Popular Astronomy

Vol. LI, No. 2 FEBRUARY, 1943 Whole No. 502

The Sixty-Ninth Meeting of the American Astronomical Society

By DEAN B. McLAUGHLIN

The sixty-ninth meeting of the American Astronomical Society was held at Northwestern University, Evanston, Illinois, on the invitation of Dr. Oliver J. Lee, Director of the Dearborn Observatory. Members first assembled Monday afternoon and evening, December 28, and the meeting was over by about noon on Wednesday, December 30.

Headquarters were at the Zeta Tau Alpha House, where the visitors had comfortable rooms. This was within easy walking distance of the restaurants in the business section, on the one hand, and the Dearborn Observatory and Technological Institute on the other.

About thirty members attended,—mostly from within a radius of three hundred miles. Dr. Burns, of Allegheny, Pierce of Princeton, and Baldwin from Silver Spring, Maryland, were the only ones who came from a considerably greater distance. The meeting could therefore be described with fair accuracy as a regional one, though it is counted on the books as a national meeting. A large attendance was not expected, in view of the rationing of gasoline and the "don't travel by rail" propaganda (which resulted, in some cases, in the trains being half empty!). However, even the normal attendance of one hundred or so would have placed a truly negligible burden on the railroads. With the A.A.A.S. meeting in New York, which would have drawn several thousands, it would have been quite a different matter, and it is easy to see why it had to be cancelled.

The Secretary and Mrs. McLaughlin left Ann Arbor Monday morning and arrived in Evanston early in the afternoon. Chief impressions of the trip were: (1) the Michigan Central coaches were not overcrowded, though pretty full; (2) the elevated railway out to Evanston seems to have as many curves as the road up Mount Hamilton.

The President and Secretary were among the early arrivals. A Council dinner was scheduled for six o'clock at "Cooley's Cupboard." The Council went there in a body, and were ushered to a small dining room by a succession of attractive young ladies, each of whom convoyed the group part way and turned it over to the next. (The President was somewhat disappointed that they didn't convoy us out again when we were leaving.) The routine business of the program, new members, and other ordinary items, was transacted between courses at first, but

later some of it was carried on during the dessert. The Secretary discovered that a pencil makes a very poor spoon, and *vice-versa*.

The session continued in a leisurely fashion after the end of the meal. What a change from the exhausting Council meetings of a year or two ago! War undoubtedly is what William Tecumseh Sherman said it is, but it does make for simpler and less strenuous A. A. S. Council meetings.

The reception for the Society by Northwestern University was at eight o'clock at Scott Hall. A small but congenial group gathered and spent a sociable hour and a half, and met Vice-President and Mrs. Harry F. Wells, Professor and Mrs. Harold T. Davis (chairman of the Department of Mathematics), and Commander and Mrs. S. D. A. Cobb. Later the astronomers returned to the Zeta Tau Alpha house and continued their general, and in some cases technical, discussions.

Sessions for papers were held Tuesday morning and afternoon in a physics lecture room of the Technological Institute. This building stands on the former site of the Dearborn Observatory,—as well as on a good deal of adjoining ground. The Observatory was moved several hundred feet closer to the Garrett Biblical Institute a few years ago. During the author's student days, a large number of houses in Ann Arbor were moved to make room for new University buildings. Much of the work was done at night, so that cutting light and phone wires would cause a minimum of inconvenience. One night an inebriated citizen was returning home in the wee small hours, when he was stricken with mortal terror on seeing a house moving through the street. He has been "on the wagon" ever since. The reader can perhaps see the connection of this seemingly irrelevant anecdote with the present subject when a Northwestern yarn has been recorded. About a quarter century ago, a dormitory of the Garrett Biblical Institute was completely destroyed by fire. Whether true or not, at least the tale that was told about the origin of the fire was somewhat as follows. Some students were gambling, and a brawl developed over an extra ace in the deck. A whiskey bottle was upset and its contents caught fire from a cigarette. Now, you see where there is some method in this madness of a peripatetic observatory!

But to return to the program, the Tuesday sessions were sufficient for the presentation of most of the papers, including several by absentee members. Thus a clear field was made for the Wednesday morning meeting on Science Courses in the War Effort, and it was certain that no session would be necessary on Wednesday afternoon. Most of the papers were spectroscopic or astrophysical in character, and Yerkes Observatory accounted for nearly half of the program. Several papers had been sent on from Victoria, and most of these were presented by members who were "primed" for the occasion.

After the Tuesday afternoon session, the members were received at

the Dearborn Observatory, and tea was served. Principal objects of interest were the 18-inch refractor, which began its career with the discovery of the companion of Sirius, and a mural entitled "Space," which was a composite of many celestial scenes. It occupies the south wall of the entrance hall.

The Society dinner was held at seven o'clock that evening, in a large private dining room of the Vera Megowen Tea Room (a much too modest name for the establishment!). The after-dinner program was fairly short. President Stebbins pointed out that no Yerkes astronomers had been asked to make speeches, since they should not be expected to come to Evanston just to listen to one of their number, and anyway they had already talked enough. Brief speeches were made by R. C. Huffer of Beloit, C. K. Seyfert of Warner and Swasey Observatory, and by Dr. Lee. The program was concluded by a resolution of thanks to our hosts, presented by Dr. Greenstein, and adopted by acclamation.

The party disbanded soon after that, and most of the Yerkes contingent left for home at that time. Those who lived at the Zeta Tau Alpha house returned there. A song-fest (C. M. Huffer at the piano), bridge, and general small-talk, occupied the remainder of the evening.

A Council meeting was scheduled for breakfast time on Wednesday, but only the President, Treasurer, and Secretary were on hand, so there was no quorum. There was not very much business to transact anyway, and what there was can be handled by mail in due time. Incidentally, it was discovered that, although people are "invited" to breakfast at Cooley's Cupboard, they do not start serving breakfast until 8:30. That must prove something, but what?

At the Wednesday morning session of the Society, a small but interested group gathered. A couple of papers left over from the program were presented, and then the discussion on "Science Courses in the War Effort" got under way. The first speaker was Vice-President Fred Fagg, of Northwestern University, who outlined briefly the war program of the University, and who introduced the succeeding speakers. Next was Professor G. Donald Hudson, of the department of geography, who discussed the science courses, in particular the pre-induction courses in astronomy of navigation, map interpretation, mathematics, physics, and meteorology. It may be remarked here that a free booklet on these courses may be obtained on request from Northwestern University.

The remainder of the program centered rather closely about navigation and allied portions of astronomy. Commander S. D. A. Cobb, Head of the Department of Naval Science and Tactics, made a special point of the importance of distinguishing between navigation and nautical astronomy, and making sure the student understands the distinction. Navigation must be taught by an experienced navigator; nautical astronomy can be taught by an astronomer, but should not be called

"navigation," since it is only a part of the subject. Students who have not a clear understanding of the difference are seriously handicapped when they actually come to study navigation under naval officers.

Mr. E. L. Edmondson, Director of Aeronautics and Coordinator of C.A.A. War Training Service, spoke on air navigation. He particularly emphasized the conditions under which the combat pilot has to fly, over strange country with inadequate charts, or over water where all waves look alike. Under such conditions a practical working knowledge of fundamental principles of astronomy is essential. Elementary physics and practical mathematics are likewise indispensable, and the ability to solve problems rapidly by approximate and graphical methods is of utmost importance.

An animated discussion followed. Dr. Lee presented another aspect of the use of elementary astronomical knowledge when he showed the importance of quick orientation by azimuths of celestial bodies. In many cases an eye estimate of the heading of the plane by reference to objects of known azimuth will enable a pilot to fly in the general direction of his base, and at least reach friendly territory. Dr. N. L. Pierce discussed pre-training for navigators. He pointed out that the requiring of college mathematics could lead to waste of time; what is needed is not coordinate geometry and calculus, but review of high school mathematics, especially trigonometry, and much practice in computation. This can be given effectively in a course in navigation which contains many drill problems, and such a course can be given in a college, leaving special technical matters to the service schools. He stressed the importance of thorough understanding of problems of relative motion and of vectors. Further, for the non-navigator, a knowledge of fundamentals and of some approximate methods may be a true life-saver.

The session ended about noon, and the group disbanded quickly. Luncheon was something of a problem, as all the restaurants were overflowing with people, even at 1:30 P.M., but after making the rounds, our group did manage to squeeze in at the Orrington Huddle.

The return to Ann Arbor was uneventful, and again the train was full, but not overcrowded. In this connection the author recalls his trip in the east last summer, when dozens of people were standing in the aisles of coaches. And some of the coaches were of a vintage not seen these many years; they would have been scrapped years ago, had the railroads not forgotten they had them!

Definite action has not yet been taken by the Council concerning the next meeting. That was left in the hands of the President and Secretary. There is every prospect that, unless war conditions make it impossible, the seventieth meeting will be held at Harvard in connection with the centennial of the Harvard College Observatory, some time in the summer of 1943.

ANN ARBOR, MICHIGAN, JANUARY 9, 1943.

Popular Astronomy

The First Fifty Years

By CURVIN H. GINGRICH

Due to lack of space, it was impossible to complete the paper under this title in the preceding issue. We, therefore, add here those complimentary messages in connection with the Fiftieth Anniversary, which could not be included before. These, as the earlier ones, appear in the order in which they were received.—EDITOR.

Sincerest congratulations to POPULAR ASTRONOMY on the completion of a half-century of excellent service. This journal fills a unique place in our astronomical literature and is an inspiration to all interested in astronomy, especially to those for whom this subject is an interesting and delightful hobby and to those who are teaching it as a general cultural arts course or as a course in applied mathematics.

May the next fifty years be marked by even greater success. Best wishes to the editors in this worthy cause.

H. R. KINGSTON.

THE UNIVERSITY OF WESTERN ONTARIO.

I remember when the good ship POPULAR ASTRONOMY was launched and when it made its first call at Toronto. Since then its periodic visits have continued with the regularity of a heavenly body, and it has always been filled with solid and useful material. During the past fifty years there has been an enormous, indeed phenomenal expansion of the cultivation and application of science on the North American continent, and POPULAR ASTRONOMY has well performed its modest part. I tender my congratulations and best wishes as it begins the second half of its first century.

C. A. CHANT.

DAVID DUNLAP OBSERVATORY.

During its first half-century POPULAR ASTRONOMY has well served the interest of the general reader in the progress of astronomy. Among teachers and professional astronomers it has a definitely recognized place, and in the astronomical literature the reference to P.A. is familiar to everybody. May it continue to further the promotion of the queen of sciences in America!

G. VAN BIESBROECK.

YERKES OBSERVATORY.

Fifty years ago two eminent astronomers, William W. Payne and George E. Hale, decided to create two new astronomical journals. They had for some years been associated as the editors of *Astronomy and Astrophyics*, described as an "international magazine devoted to the old and new astronomy." In September, 1893, POPULAR ASTRONOMY ap-

peared as the first of the two new journals, under the editorship of Professor Payne and Miss Willard; two years later Professor Hale started the *Astrophysical Journal* at the University of Chicago. Both periodicals are, in a sense, the children of the older *Astronomy and Astrophysics*, which was discontinued soon after the birth of the *Astrophysical Journal*. It is not surprising that throughout the years there has always been a close friendship between the two journals, and today *The Astrophysical Journal* takes pleasure in extending cordial greetings to her older sister upon her fiftieth anniversary.

Popular Astronomy has had a distinguished history. The first volume contains articles by many leading astronomers of a past generation: Keeler wrote on spectroscopy, Kirkwood on asteroids, Parkhurst on variable stars, Barnard on the newly discovered fifth satellite of Jupiter and on the Gegenschein, Burnham on double stars. These articles, and many later ones, were informative and were often useful to professional astronomers as well as to amateurs.

In the great struggle in which the world is locked today astronomy has an important task to perform. No other science is so well adapted to uplift the minds of people and to restore faith in ultimate law and order in the souls of men who have lost their ideological bearings. Millions of young men who risk their lives on the battle fronts of the world and other millions who have been torn from their families or have lost their homes, and finally those millions of people in totalitarian countries who today are beginning to witness the crumbling of their false ideals, must be restored in their faith in the unity of the world. What more sublime spectacle than the outburst of a brilliant nova can so completely change one's outlook and restore one's mental and moral equilibrium in times of distress?

I recall an incident during the last war, when I was a young artillery officer in the Russian army. The war had been lost, our families and our homes had been abandoned to a cruel enemy and certain death or exile stared us in the face. And then one night, in the summer of 1920, on the shore of the Black Sea, when everything seemed lost, I saw a brilliant star which I had never seen before in the constellation Cygnus. This single event had an extraordinary effect upon me. It restored my interest in astronomy and removed the paralyzing agony of despair. It gave me strength to endure the final misery of defeat, and confidence in a new and better world.

Let Popular Astronomy continue to carry the message of our science to those who are enduring hardship and suffering in this war. Let its owners, editors, and contributors shoulder the greatest responsibility for providing what no other journal now provides: the dissemination of astronomical information not for the purpose of supplying technical data to professional workers, or for the purpose of giving easy and pleasant entertainment, but to elevate the minds of people from the im-

mediate problems confronting them to the contemplation of the wonders of the universe. Laplace has well said: "astronomy by the dignity of its object and the perfection of its theories is the most beautiful monument of the human mind, and the most noble title of its intelligence."[1]

McDonald Observatory. Otto Struve.

[1] Popular Astronomy, **2**, 292, 1895.

Congratulations on the semi-centennial of Popular Astronomy. I well remember the time when Professor Payne and Professor Hale gave up the publication of *Astronomy and Astrophysics* to launch Popular Astronomy on the one hand and *The Astrophysical Journal* on the other, and great successes have these proven to be. Popular Astronomy has time and time again offered itself as a medium for the publication of papers for which it would have been difficult to find a proper channel and has thus done its share in furthering astronomical research in this country. The American Astronomical Society has reason to be especially grateful to this journal for timely help, and its indebtedness has often been voiced at meetings of the Council and of the Society itself. May the next half-century prove as striking in the history of Popular Astronomy as the last has been.

Frank Schlesinger.

Lyme, Connecticut.

May I offer felicitations to the editor and staff of Popular Astronomy upon the completion of fifty annual volumes! From the day more than twenty years ago when as a student I discovered Popular Astronomy, to the present time, I have followed it with interest. I look forward to the future with undiminished enthusiasm. May the next fifty volumes be as well filled with astronomical news and knowledge as the last!

Ladd Observatory, Brown University. Charles H. Smiley.

I have known Popular Astronomy from the very first issue, and it is a pleasure to offer my congratulations to the magazine and to its editors upon the completion of fifty years of successful publication.

In all of these years it has been an important factor in astronomical progress; it has furnished a medium for the publication of reports of various societies; it has contained a wealth of information of great value to the amateur and has helped much in the arousing and maintaining general interest in things astronomical.

Anne S. Young.

Claremont, California.

It is a pleasure to send a word of congratulation to Popular Astronomy on the occasion of the completion of its fiftieth volume, for a unique job steadfastly carried out, and to wish it equal success with the next fifty volumes.

Edwin F. Carpenter.

Steward Observatory.

The celebration of 50 years in the history of POPULAR ASTRONOMY recalls a number of more or less personal recollections which may not be wholly out of place at this time.

My first contact with the magazine occurred when I was still in high school. I had written to Dr. E. S. Holden, at that time director of the Lick Observatory, asking if the observatory published anything for the amateur astronomer. He replied that nothing of the kind was published by the observatory but suggested I write to Professor W. W. Payne and obtain a sample copy of the then new POPULAR ASTRONOMY. Not long thereafter a sample copy was received and soon I became a regular subscriber.

POPULAR ASTRONOMY did me the great honor of publishing my first astronomical contribution—a chart and notes on the ill-fated Leonid shower of 1899.

Professor Payne, the founder and for many years the publisher and editor, was a unique character. After his graduation from Hillsdale College he studied law and began practice in a small community near Northfield. While engaged in practice he studied astronomy by himself and after Carleton College opened he became its first professor of mathematics and astronomy. For 10 years he published *The Sidereal Messenger,* then, in collaboration with Dr. George E. Hale, *Astronomy and Astrophysics,* and, when the joint enterprise ended by the publication of *The Astrophysical Journal,* he started POPULAR ASTRONOMY.

He was a prodigious worker. In addition to carrying a full load of teaching in mathematics and astronomy he carried the extra burden of publishing and editing POPULAR ASTRONOMY and was very active in Church and Sunday School. His work day began with a class in astronomy at 8:00 A.M. He seldom left the observatory before 6:00 P.M. and often came back to his desk after the evening meal and worked until late. Then he usually took class papers and editorial material home with him. He never had a brief case to carry his material but always a rather ornate basket. One of my most vivid recollections as a student is the picture he made as he crossed the large open area in front of the observatory, heading directly for the front door of the observatory and carrying the basket of material on his left arm.

At one time there was some disagreement with the printer. In a few days fonts of type were purchased, a typesetter put in an appearance, and the upper floor of the observatory became a composing room pervaded by the odor of benzine and printer's ink. This continued for some years before the feud was settled.

During the early days of POPULAR ASTRONOMY Professor Payne was ably assisted by Miss Charlotte Willard and Dr. H. C. Wilson. They not only helped edit but also wrote for the publication.

POPULAR ASTRONOMY has been a real contribution to astronomy in

the past half-century. My wish for it is that it may be still more useful in the years to come.

E. A. FATH.

GOODSELL OBSERVATORY.

It is always a pleasure to read POPULAR ASTRONOMY. It contains an excellent balance of the non-technical with the technical, such that the layman interested in things astronomical is not completely lost. The advance of science, and the manner in which its advance is made known to the average reader, is splendidly furthered in the columns of your publication. At the beginning of the New Year it is a pleasure to express appreciation and to send wishes for long continued service.

THE WARNER & SWASEY CO. WARNER SEELY.

Astronomy in the Service of Culture

By ROY K. MARSHALL

(Continued from page 27)

In his address* at the dedication of the Swasey Observatory of Denison University, June 15, 1910, the late Edwin B. Frost said, "The early philosophy concerned itself with astronomy to a degree which, even an astronomer must admit, was disproportionate to the benefits it was conferring upon humanity." I am not quite sure how "early" Dr. Frost meant to go, nor how late, but surely in the record of these mighty discoverers we can find more than enough to justify the expenditure of princely sums. Think of the vistas of human experience opened by the speculations of Thomas Wright of Durham, and Immanuel Kant of Königsberg! A world without end, filled with "Island Universes," in place of what Shapley has called the "little gob of earth, with its splash of ocean, wisp of atmosphere, and smear of biology," surrounded by wheeling crystalline spheres! Laplace, with his nebular hypothesis (never mind the fact that we today discredit it!)—

> "Regions of lucid matter, taking form,
> Brushes of fire, hazy gleams,
> Clusters and beds of worlds, and bee-like swarms
> Of suns, and starry streams."
>
> (Tennyson, "The Palace of Art")

Fraunhofer, Kirchhoff, Bunsen, Huggins! What divine inspiration and what mortal impudence for them to delve into the stars with their prisms and bring out the secrets of their compositions, temperatures, constitutions, their very motions! Think upon the discovery of helium in the sun, and its discovery on the earth a generation later! The imagination is fired by events like these, and the history of our science in full of them.

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*POPULAR ASTRONOMY, Vol. XIX, No. 8, October, 1911.

Think of William Huggins who told us of one of the thrilling moments in the history of science: "On the evening of the 29th of August, 1864, I directed the telescope for the first time to a planetary nebula in Draco. The reader may now be able to picture to himself to some extent the feeling of excited suspense, mingled with a degree of awe, with which, after a few moments of hesitation, I put my eye to the spectroscope. Was I not about to look into a secret place of creation? . . . I looked into the spectroscope. No spectrum such as I expected! A single bright line only! At first, I suspected some displacement of the prism, and that I was looking at a reflection of the illuminated slit from one of its faces. This thought was scarcely more than momentary; then the true interpretation flashed upon me. The light of the nebula was monochromatic, and so, unlike any other light I had as yet subjected to prismatic examination, could not be extended out to form a complete spectrum. . . A little closer looking showed two other bright lines on the side toward the blue, all the three lines being separated by intervals relatively dark. . . The riddle of the nebulae was solved. The answer, which had come to us in the light itself, read: Not an aggregation of stars, but a luminous gas."

Such a man, like Kepler, could "indulge his sacred fury." He might indeed with Ptolemy sing,

> "I know that I am mortal, and belong
> To the vile sod I tread; yet when I raise
> My thoughts to heaven, and mingle in the throng
> Of worlds that labour in a close-ravelled maze,
> No longer then with the base earth I link
> But am with Jove indeed amid his ways,
> Share the same skies—from the same fountain drink."

There is no part of modern astronomy which is much more abstruse than this field in which Huggins did such splendid pioneering; yet there is nothing in the whole field of human endeavor which so approaches magic. What a pity that Walt Whitman could not have known something about the prism and its work; he might have penned something worthier of himself than the nonsense of "When I heard the learn'd astronomer. . . How soon unaccountable I became tired and sick."

The appeal to the imagination that astronomy makes is one of its most notable contributions to culture. Facts almost beyond human comprehension have come to light, and have been put into such simple terms that even the veriest layman is vaguely familiar with such expressions as supernovae, the expanding universe, and relativity. Those of us who are privileged to talk to and with these laymen sense better than anyone else a certain gratitude for knowledge. The time is past, thank heaven, when new things are shunned because, being new, they must not be good. Old Copernicus put an unanswerable argument when he said, "To know the mighty works of God, to comprehend his wisdom and majesty and power, to appreciate, in degree, the wonderful working of

his laws, surely all this must be a pleasing and acceptable mode of worship to the Most High, to whom ignorance cannot be more gratifying than knowledge."

Poets have sprung into print with the newest thing in astronomical discovery. These kindred souls to the astronomer have been stirred by the facts. Remember Milton's lines about Galileo's telescope:

> "The moon, whose orb
> Through optic-glass the Tuscan artist views
> At evening from the top of Fesolé
> Or in Valdarno, to descry new lands,
> Rivers or mountains in her spotty globe."

Tennyson has many passages in which he has referred to astronomy and to new discoveries. In his poem, "Maud," he says,

> "It fell at a time of year
> When the face of night is fair on the dewy downs,
> And the shining daffodil dies, and the Charioteer
> And starry Gemini hang like glorious crowns
> Over Orion's grave low down in the west."

How much nicer than to say—"It was in May."

In "The Palace of Art," we find,

> "And 'while the world runs round and round,' I said,
> 'Reign thou apart, a quiet king,
> Still as, while Saturn whirls, his steadfast shade
> Sleeps on his luminous ring.' "

And we are all familiar with his lines in "Locksley Hall," written shortly after the Brothers Henry had photographed the Pleiades with one of their new telescopes in Paris:

> "Many a night from yonder ivied casement, ere I went to rest,
> Did I look on great Orion sloping slowly to the West.
> Many a night I saw the Pleiads, rising thro' the mellow shade,
> Glitter like a swarm of fire-flies tangled in a silver braid."

In "Locksley Hall—Sixty Years After," Tennyson indulges in an astronomical fantasy:

> "Ay, for doubtless I am old, and think gray thoughts, for I am gray:
> After all the stormy changes shall we find a changeless May?
> Earth at last a warless world, a single race, a single tongue,
> . . . . . .
> Warless? war will die out late then. Will it ever? late or soon?
> Can it, till this outworn earth be dead as yon dead world the moon?
> Dead the new astronomy calls her . . .
> . . . . . .
> Dead, but how her living glory lights the hall, the dune, the grass!
> Yet the moonlight is the sunlight, and the sun himself will pass.
> Venus near her! smiling downward at this earthlier earth of ours,
> Closer on the sun, perhaps a world of never-fading flowers.
> Hesper—Venus—were we native to that splendor or in Mars,
> We should see the globe we groan in, fairest of their evening stars.
> Could we dream of wars and carnage, craft and madness, lust and spite,
> Roaring London, raving Paris, in that point of peaceful light?
> Might we not in glancing heavenward on a star so silver-fair,
> Yearn, and clasp the hands and murmur, "Would to God that we were there?"

There's a lot of astronomy in that set of verses; Tennyson used up half a page telling us how well he knew the state of astronomy. He knew, for example, that the Moon has no air or water, and that it reflects sunlight. He knew that Venus is nearer the Sun than is the Earth. He knew that from Mars the Earth would be seen only in the early evening or in the morning just before sunrise, as Venus appears to us. He knew that from either Venus or Mars the Earth would be a brilliant object, the most beautiful in the sky.

Literal astronomy, new at the moment, we find, too, in Milton's description of the Milky Way as

> "A broad and ample road, whose dust is gold
> And pavement stars. . ."

For almost four centuries, new observations and new theories have titillated our minds almost every year. Some of the observations have negated theories, and we have had to build them anew. That is another lesson taught mankind by modern science: We no longer fear to change our minds. We grow less ashamed of being unable to make a pretty and exact model of the universe; we resolve to hew close to the line of truth, taking that which is best and rejecting that which cannot be proved, however attractive it may seem. We have lost all fear of treading into unknown places in Nature; our impudence is surpassed only by our knack of coming out right in our speculations and investigations. We know that to progress we must never be content to stand still. Over the door of the public library in Rochester there is this:

> "The shadows will be behind you if you walk into the light."

So far, most of my quotations and most of my mention of workers in astronomy have concerned writers and scientists of the Old World. Now I wish to tell the story of one of the most inspiring of astronomical episodes, one which happened about a century ago, and in this our New World.

In 1832, George Airy, later to become Astronomer Royal, said in a report to the British Association for the Advancement of Science,

> "I am not aware that there is any public observatory in America, though there are some able observers."

He was not saying anything not well appreciated by leading thinkers on this side of the Atlantic. In George Washington's first message to Congress, he said,

> "Nor am I less persuaded that you will agree with me in opinion that there is nothing more deserving your patronage than the promotion of science and literature."

While he was Secretary of State, in 1812, James Monroe, later President, urged Congress to establish a national observatory. There was a feeble effort made at Harvard, for the establishment of an observatory, from 1805 to 1822, and it might have come out very well if there had

been greater appreciation of the pledge of $1000 by John Quincy Adams in 1823. The condition of this gift was that others should contribute a like amount, and no other contributors could be found.

John Quincy Adams became President of the United States in 1825, and in his first message to Congress he said,

> "It is with no feeling of pride, as an American, that the remark may be made that, on the comparatively small territorial surface of Europe there are existing upward of one hundred and thirty of these lighthouses of the skies; while throughout the whole American hemisphere there is not one."

Throughout his administration of four years he tried to get a national observatory established, but the phrase "lighthouses of the skies" became a jibe used by his opponents. This remarkable man retired from the Presidency and was almost immediately drafted to serve in the House of Representatives. There he earned the love and admiration of all who worked with him. He served on many of the most important committees, and one of them was the committee for consideration of the proposed gift of James Smithson, the Scotsman who never saw this country, but who left his fortune to us. In 1840, Adams wrote this, as he urged the use of the Smithson money, or the first portion of it, for his pet project:

> "The express object of an observatory is the increase of knowledge by new discovery. The physical relations between the firmament of heaven and the globe allotted by the Creator of all to be the abode of man are discoverable only by the organ of the eye. . . The influence of [the heavenly bodies] upon the globe which we inhabit, and upon the condition of man, its dying and deathless inhabitant, is great and mysterious, and, in the search for final causes, to a great degree inscrutable to his finite and limited faculties. . . The extent to which [these final causes] are discoverable is and must remain unknown; but, to the vigilance of a sleepless eye, to the toil of a tireless hand, and to the meditations of a thinking, combining, and analyzing mind, secrets are successively revealed, not only of the deepest import to the welfare of man in his earthly career, but which seem to lift him from the earth to the threshold of his eternal abode; to lead him blindfold up to the council-chamber of Omnipotence, and there, stripping the bandage from his eyes, bid him look undazzled at the throne of God."

But none of the Smithson money was used to establish an observatory, and Adams was again disappointed. Time and time again he and some kindred souls framed bills in Congress for the establishment of a depot for charts and chronometers, and for the provision for the observations necessary to conduct navigation, only to have some opponent tack on a rider to the effect that "under no circumstances must the provisions of the bill be construed as providing for the establishment of a national observatory." But five hundred miles to the west events were brewing which were to bring joy to the heart of John Quincy Adams.

About six months after the birth of Abraham Lincoln, there was born in Morganfield, Kentucky, Ormsby McKnight Mitchel. As a lad, he was taken to Lebanon, Ohio, where he had his primary education. I

might be forgiven for interpolating here that I, too, had most of my primary and all of my secondary education in Lebanon, Ohio, and it was there that I began to know that I must be an astronomer. Mitchel went to West Point, and returned in 1834 to Cincinnati, where he was appointed professor of mathematics, philosophy, and astronomy in the new college which had been founded.

He was a brilliant teacher; imagine a professor so interesting that his students insisted that their parents accompany them to the classroom, to hear his lectures, particularly on astronomy! At last he yielded to persuasion, and in the winter of 1841-42 he gave a course of lectures on astronomy before the "Society of Useful Knowledge." One by one, the capacities of the leading auditoriums in the city of Cincinnati were exhausted by the attendance at Mitchel's lectures. At the conclusion of the last lecture of the series, before a throng which overflowed the largest hall in the city, Mitchel asked permission to suggest something that was dear to him and something which might meet with favor in the minds of his hearers. He suggested the formation of an astronomical society, with subscriptions of $25 each, with which to purchase a fine telescope and build an observatory. Enthusiasm was high, and the project of the Cincinnati Astronomical Society was established. About $3,000 was collected at once, and the project of the observatory then seemed certain. Judge Nicholas Longworth gave four acres of land atop Mount Auburn, as fine a site as the land near the city afforded, and the work was started.

Then Mitchel got in touch with John Quincy Adams, for the sympathy of the former president of the United States for astronomy was well known throughout the country. Adams, then aged 77, responded warmly to the invitation of Mitchel to attend the laying of the corner stone of the observatory; these are his words:

> "Sir, if I were to follow the impulse of my present feelings, I would unhesitatingly answer 'yes, I will go at the risk of my life,' for God knows that if I could be spared to participate in so interesting a ceremony, one that I feared I should never witness, I would be willing to die the next day. My hopes would be more than realized, and the toil of twenty years fully repaid."

We read in this some small reluctance actually to promise to attend, but his half-resolution seems to have been crystallized by the opposition expressed by his supposed friends in Massachusetts. We find him rebuking them for their questioning the propriety of his going out to the wilds of the Ohio for such a purpose. In an address on July 4, at Dedham, Massachusetts, in 1843, he said,

> "From the Ptolemies of Egypt and Alexander of Macedon, from Julius Caesar to the Arabian Caliphs Haroun al Raschid, Alamon, and Almansor, from Alphonso of Castile to Nicholas, the present Emperor of all the Russias,—who, at the expense of one million rubles, has erected at Pulkova the most perfect and best-appointed observatory in the world, —royal and imperial power has never been exercised with more glory, never more remembered with the applause and gratitude of mankind, than

> when extending the hand of patronage and encouragement to the science of astronomy. You have neither Caesar nor Czar, Caliph, Emperor, nor King, to monopolize this glory by largesses extracted from the fruits of your industry. The founders of the constitution [of the Commonwealth of Massachusetts] have left it as their dying commandment to you, to achieve, as the lawful sovereigns of the land, this resplendent glory to yourselves—to patronize and encourage the arts and sciences, and all good literature."

Adams left Quincy, Massachusetts, on October 25, and at Buffalo and Columbus he was warmly greeted. His progress became almost a procession. He was met at Columbus by a delegation of the leading citizens of Cincinnati, who escorted him to the banks of the Ohio. There, in a driving rain, on November 9, 1843, he laid the corner-stone of the Cincinnati Observatory, atop a hill whose name was soon thereafter changed from Mount Auburn to Mount Adams. There in the rain, before a great throng, he gave a masterly address in which he traced the history of astronomy, and many details of its accomplishments, and told a little of his own unrewarded efforts to have observatories established on this continent. One phrase he used demonstrates again his conviction that astronomy is the noblest of the sciences:

> "The progress of a people on its career of civilization can be gauged by the number of observatories on its soil."

Adams returned to Washington, and Mitchel returned to the task of raising another $6000 to pay for the observatory and telescope. When he could not collect cash, he collected produce or goods, and traded them for cash or labor. At times he accepted a few days' use of a team and a scraper or harrow or wagon, and drove the team himself, grading the grounds and hauling stone from the quarries nearby which had been opened to obtain stone for the building. Mitchel went to Europe in 1844; before he left, he visited Washington, to obtain from President Tyler letters of introduction to influential persons abroad. He was sent from office to office, and found only one man in Washington, John Quincy Adams, who would give him the necessary credentials. These gained him entree to all the best science establishments in the old world. He visited the Royal Observatory, and the old Herschel house at Slough and when he went to the continent he found at Fraunhofer's old firm at Munich a superb objective almost 12 inches in diameter, at that time inferior in size only to the great 15-inch at Pulkova. The money asked for it was more than he had counted on, however, but he had faith in his ability to raise the difference, so he paid a deposit on the lens, and returned home once more to the arduous task of raising money. At last the instrument was delivered, in February of 1845, and observations were begun at once.

Then came a blow which would have been too much for another man to bear. The Cincinnati College, from which came Mitchel's only livelihood, burned, not to be rebuilt. Mitchel had pledged his services for five years, without pay, to the directorship of the observatory, and he

had to raise more funds in some way, so again he took to the lecturing platform. In Boston, and in New York, long queues formed to gain admission to the halls where he spoke on the wonders of the universe; and these were all paid admissions, mind you! In New York he raised the enthusiasm of his listeners to such a pitch that an observatory project for Central Park was started, but without his enthusiastic presence it died, some time later. He lectured often, and wrote books, and started a journal *The Sidereal Messenger,* which ran to 10 volumes. He kept himself and the observatory and the Cincinnati Astronomical Society alive, and then came the war between the states.

Mitchel had attended West Point, and in the war he was a general. Astronomy had to be put aside for the brutal business of butchery, but even the glory of death on the battlefield for his country was denied Mitchel. He died in camp, of a fever which swept through the ranks and struck officers and men alike.

Today the reason for the name of Mount Adams is almost forgotten; the Cincinnati Observatory has been moved to a more suitable location, farther from the lights and smoke of the city; a larger instrument, a 16-inch by Alvan Clark, graces a larger dome, but the old 11½-inch Merz refractor is still in service, devoted particularly to the instruction of the public on certain nights each month. It was the first observatory I ever visited. The ghost of Ormsby McKnight Mitchel was there, and it was his voice I heard, but coming from the lips of the venerable Jermain G. Porter, as the light of the quarter-moon slanted through the narrow slit and fell athwart the old mounting of what was at one time the second-largest refractor in the world. It was an impressive moment when I stepped into that old dome, and heard the whirring and clicking of the driving clock.

I have had the privilege of introducing others to the beauties of astronomy, in observatory domes. I think no one should see a telescope in its dome by day, except the mechanics and the custodians of the woodwork. If you have experienced, as I have, the thrill of discovering the giant Yerkes telescope late at night, with a tiny eye in the observer's light across that mammoth elevator-floor, and only the soft light of the stars otherwise, you will agree with me. Your footfalls seem a desecration of some temple dedicated to the pursuit of truth in far fastnesses of space and time. You expect the observer to be shrouded in monkish robes, with a face in which the peace of all eternity can be seen. I have been working with telescopes in large observatories for 17 years, yet I can never lose that feeling of awe and reverence when I first step beneath an infrequently-visited observatory dome. Tycho never observed the stars without first donning his finest court robes.

I feel it so much myself, and have seen it so often evidenced in others, that I foster it in those who are likely to experience it. I have been occasionally surprised at my observing by strangers who have walked

in uninvited, and I have done my best to make no sudden movement, nor to speak loudly, for they stand in utter silence, or speak in the most hushed tones, and sometimes go away without asking a question, closing the door softly behind them. Perhaps it is fatuous, but I believe any man will be a better man if he can have that experience.

The entry in Emerson's Journal for November 14, 1865, is this:

> "I saw tonight in the observatory at Williamstown, through Alvan Clark's telescope, the Dumb-Bell nebula in the Fox and Goose Constellation; the four double stars in Lyra; the double stars of Castor; the two hundred stars of the Pleiades. . . Of all tools, an observatory is the most sublime. . . The dim lanthorn which the astronomer used at first to find his object-glasses, etc., seemed to disturb and hinder him, preventing his seeing his heavens, and, though it was turned down lower and lower and lower, he was still impatient, and could not see until it was put out. When it had long been gone, and I had looked through the telescope a few times, the little garret at last grew positively lightsome, and the lamp would have been annoying to all of us.
>
> "What is so good in a college as an observatory? The sublime attaches to the door and to the first stair you ascend; that this is the road to the stars. Every fixture and instrument in the building, every nail and pin, has a distinct reference to the Milky Way, the fixed stars, and the nebulae, and we leave Massachusetts and the Americas and history outside at the door, when we come in."

Surely to ponder the infinite is to strengthen the human spirit; surely to be made to feel that man is capable of nobler things than brutality toward his fellow man, or than the pushing of goods across a counter in exchange for minted metal, is a contribution to culture. Astronomy teaches us perhaps to share a "Surmise" by Roland English Hartley (*Harper's,* October, 1939):

> "Do they look up, those others, from a world
> That swings about a star in fields of space?
> Do they look out when all their night is pearled
> With constellations, studying to trace
> The movements of our faintly shining sun?
> And do they think its planetary net
> May hold these swimming worlds—and dream of one
> Where beings like themselves live hard beset?
> Perhaps they think that this far Earth of ours
> Receives their choicer spirits after death,
> To live where truth prevails and beauty flowers;
> Perhaps they think that here we sense the breath
> Of universal order and abhor
> Their own sad commonplace of ceaseless war."

Fels Planetarium, The Franklin Institute, Philadelphia, Pa.

Marvelous Voyages — V

H. G. Wells' The First Men in the Moon-Part I

By LAURENCE J. LAFLEUR

As in the case of Jules Verne's lunar adventures, the story of H. G. Wells may be conveniently treated in two parts, the first consisting of the trip itself and the second of what befell there.

Cavor, a scientist and inventor, is the hero of Wells' tale. He has concluded that a substance is possible which would be opaque to gravitation as well as to all other forms of radiation, and in consequence he sets about making it. The substances of which this is to be formed include a number of metals and some other things as well, formed into a paste. This paste is heated red-hot in a stream of helium, and then allowed to cool gradually, until the product reaches 60° Fahrenheit, at which point it attains its remarkable properties. The first time Cavor makes it, it is in the form of a thin horizontal sheet, whereupon the air above it, and portions of the roof, cease to have weight and exert pressure. So the air all about the Cavorite crushes in upon the air above it with irresistible force. The air above the sheet thus erupts skyward with explosive violence, being continually replaced by other air; and were it not for the fact that the Cavorite itself is blown away the experiment would have exhausted the atmosphere of the earth. As Cavor said, this atmosphere would have eventually dropped back, but on an asphyxiated world.

Cavorite being impractical for use within the atmosphere, a design is prepared for a Cavorite sphere to travel in space. This consists of a glass polyhedron with steel roller blinds covered with Cavorite. With the blinds open it is a normal object: when the blinds are closed it will weigh nothing and be ejected from the atmosphere: and when some of the blinds are open its course will be deflected towards any celestial objects in the direction of the open blinds. Thus the sphere can be navigated in any desired direction, and its speed accelerated or retarded.

With an associate, Bedford, Cavor builds the sphere, and in it the two set off to visit the moon. Very little apparatus is taken with them; some food, clothing, instruments, cylinders of oxygen, an electric heater, and so forth. The men take their place in the sphere before the Cavorite with which it is covered cools to its effective temperature. When the Cavorite begins to function, Bedford relates, "there came a little jerk, a noise like champagne being uncorked in another room, and a faint whistling sound. For just one instant I had a sense of enormous tension, a transient conviction that my feet were pressing downward with a force of countless tons. It lasted for an infinitessimal time." This, however, is Bedford's later report: at the time he does not realize what has happened and proposes to leave the sphere.

After a few minutes the travellers notice peculiar sensations in the head due to the absence of gravitational force, and observe that all free objects in the sphere have fallen a foot toward the center under the influence of mutual gravitation. The motion is slow and towards a point somewhat nearer the heavier man than the lighter. To meet this situation the two float back to back.

When a window is opened, Bedford is impressed by the number of stars visible when the interfering atmosphere is removed. Towards the moon four windows are opened, to get the advantage of the moon's gravitational pull on all the contents of the vehicle, and the same gravitational pull enables the men to stand on the open window. Looking down on the moon, they see it as larger and brighter than ever before. The minutest details of the surface are acutely clear, and the star-dust that covers the sky comes right to its clearly defined margin, on the illuminated as well as on the unilluminated part.

One of the curiosities of the trip is that freedom from gravitation seems to slow down metabolism. The men consume little food and little oxygen, exhale little carbon dioxide, and drowse off a large part of the time.

When at last the sphere approached the moon, they dropped ever closer as they spun about it, slackening their pace and watching for a chance to drop upon its surface. Cavor was perpetually opening and closing the windows according to calculations which he made at intervals. Using the sun's attraction as a brake they land successfully with nothing more than a jar, a half hour or so beyond the terminator in the dark portion of the moon, in a bank of snow-like frozen air. Their electric heater does good service in keeping them from freezing.

Then day came. "The sunlight had crept down the cliff, it touched the drifted masses at its base, and incontinently came striding with seven-leagued boots toward us. The distant cliff seemed to shift and quiver, and at the touch of the dawn a reek of gray vapor poured upward from the crater floor, whirls and puffs and drifting wraiths of gray, thicker and broader and denser, until at last the whole westward plain was steaming like a wet handkerchief held before the fire, and the westward cliffs were no more than a refracted glare beyond." Finally the solar prominences came into view, and then the sun. And with the sun the frozen air boiled away, tossing the sphere around, causing it to roll down a slope, and knocking Bedford out completely.

When he recovered it was full day, the glare of the sun had taken upon itself a faint tinge of amber; and the shadows upon the cliffs were deeply purple. To the eastward a dark bank of fog still existed, but to the westward the sky was blue and clear. And on the ground are sticks, and vegetation grows, grows visibly while they watch it. Oval seed pods crack open to show yellowish green within; roots grow into the ground, a bud rises and opens into a whorl of spiky brown-orange leaves. Bedford

compares it to the rise of mercury in a thermometer taken on a cold day into a warm hand, and suggests that this speed is due to growth against a gravitational pull only one-sixth that of earth.

So they test the atmosphere with burning paper, and cautiously open the manhole valve, so that they may become accustomed to the rarefied air which carries sound so poorly that their voices are hardly audible. They leave the sphere, and in an attempt to jump a barely noticeable ditch soar twenty or thirty feet. Bedford is reminded that on the moon, with only an eighth part of the earth's mass and a quarter of its diameter, his weight is barely a sixth of what it was on earth.

All around them, as far as eye can see, is the bristling vegetation, diversified here and there by bulging masses of a cactus form, and scarlet and purple lichens that grow so fast they seem to crawl over the rocks. But with all the wealth of vegetable growth, they see for some time no animal life of any sort whatsoever; and it is only after they have practiced walking and jumping for some time, losing the sphere in the meanwhile, that the second part of their adventures begins with the discovery of animal life.

(For list of errors see p. 80.)

Our First-Magnitude Stars from Afar

By O. R. WALKEY

From time immemorial have the stars been woven into constellations, and their differences in brightness been noted. Owing to the vast distances of the stars, these features are permanent—being unaffected by the motions of our Earth, the Sun, and of the individual stars. Consequently, star-gazers may fail to realize how changed would be the aspect of our sky, were we removed to a considerable distance, by stellar standards, from our terrestrial and solar system viewpoint.

It may, therefore, be of interest—as a matter of curiosity rather than of scientific value—to illustrate the effect of our removal to a viewpoint so remote as the galactic centre, 10,000 radials away in the direction Right Ascension $17^h\,40^m$, Decl. $-30°$, on the Ophiuchus-Scorpio border line. A "radial," by the way, represents the distance yielding a parallax of 1".0 of arc, and so equals a distance of 3.26 light years, or 19.16 times 10^{12} miles.

We here confine ourselves to the effect on our familiar twenty brightest stars, those of the "first" magnitude. To these we add our own particular star, the Sun, making twenty-one entries in our table. Their proper names appear in the first column, followed by the Greek letter and constellation. The next two columns give the position in galactic coordinates—according to the plane having its north polar axis pointed to (1900) R. A. $12^h\,48^m$ (192°), Decl. $+27°$, this being the

united verdict of all the objects defining the plane of our stellar universe.† The dynamic centre lies (from our viewpoint) at λ 326°, β 0°, where λ (col. 3) is the galongitude (galactic longitude) measured eastward from the intersection of our equatorial plane with that of the galaxy at R. A. $18^h\ 48^m$ (282°), Decl. 0°, in Aquila; β (col. 4) is the galatitude (galactic latitude) north (+) and south (—) from the galactic plane toward its poles. The 5th column gives the Revised Harvard Photometry magnitude (m), in which order of apparent brightness the stars are tabulated. The next column gives the "absolute magnitude" (M), or what the star's magnitude would be if removed to the International Astronomical Union's standard distance of 10 radials (parallax 0".1). A range of 1.0 magnitude, by the way, indicates (by Pogson's ratio) a 2.512 fold change in brightness, so that 5 magnitudes represent exactly 100 fold change in brightness. Whence the relation between m and M follows as, $M = m + 5 - 5 \log R$, where R is the distance in radials, as given in col. 7—the reciprocal of the parallax. The parallaxes in question are taken from the Yale 1935 *Catalogue of Parallaxes,* amended by later revisions.* The next two columns (8, 9) give, respectively, the components of R resolved perpendicular to ($R \sin \beta$) and along ($R \cos \beta$) the galactic plane in the direction λ.

Column 10 in the table gives the distance (R′) of each of our stars from the galactic centre and is nearly enough represented by the relation, $R' = 10000 - R \cos \beta \cos (\lambda + 34°)$. Column 11 gives the apparent magnitude (M′) from our adopted viewpoint, and is nearly enough in all cases represented by $M' = M + 15$.

The two final columns give the coordinates for plotting the stars from the Sun as origin, seen from our chosen viewpoint, *viz.* λ 326°, β 0°, so looking toward λ 146°, β 0°. The abscissae (x) follow from the relation, $R \cos \beta \sin (\lambda + 34°)$, while the ordinates (y) are expressed by $R \sin \beta$. The positive values for x and y indicate respectively positions to the right of and above the solar origin. The values are given in minutes of arc by reducing the values from radials by the relation 3438/10000. Hence we see the entire break-up in the familiar places of our first-magnitude stars, and in their brightness. Seen from the galactic centre, these stars would present a horse-shoe cluster lying within an area equal to our lunar disc and gathered closely round its faintest member, the Sun (twentieth magn.), which clustering is what we would expect of stars apparently bright because relatively near. Outside this clustering lie the notable exceptions Canopus, Rigel, and Arided, flank-

† See "Observatory" **64**, 264, 1942.

*These distances agree in general with those quoted in a recent article on our first-magnitude stars in POPULAR ASTRONOMY **48**, 403 (1940), except that far too small a distance is given there for α Carinae, based on an old and admittedly uncertain spectrum measure; whereas the consensus of recent parallactic measures is represented in the Yale value—endorsed too by a suggestive consideration ("Concise General Astronomy," Trivandrum, p. 272)—given in our table.

ing in a line somewhat inclined to the galactic plane. Of the twenty-one stars entered, only these three would be visible in a field-glass magnifying eight times.

Star	Cons.	λ	β	m	M	R	R sin β	R cos β	R′	M′	x
The Sun	.....	.....	....	—26.72	+4.9	0.0	0.0	0.0	10000	19.9	0.0
Sirius	α Can. Maj.	194°.0	— 9°.0	— 1.58	+1.3	2.7	— 0.4	2.6	10001	16.3	— 0.7
Canopus	α Carinae	228.2	—24.8	— 0.86	—7.6	220.0	—93.0	200.0	10027	7.4	—68.2
Lugal	α Centauri	282.6	0.0	+ 0.06	+4.4	1.3	0.0	1.3	9999	19.4	— 0.3
Vega	α Lyrae	34.4	+19.0	0.14	+0.6	8.2	+ 2.7	7.7	9996	15.6	2.5
Capella	α Aurigae	129.3	+ 3.6	0.21	—0.7	15.4	+ 1.0	15.4	10014	14.3	1.5
Arcturus	α Bootis	343.6	+69.7	0.24	—0.1	11.7	+11.0	4.1	9996	14.9	0.4
Rigel	β Orionis	176.2	—25.7	0.34	—5.7	167.0	—72.0	150.0	10130	9.3	—25.9
Procyon	α Can. Min.	180.2	+12.8	0.48	+2.9	3.3	+ 0.8	3.0	10002	17.9	— 0.6
Achernar	α Eridani	258.6	—58.2	0.60	—1.1	22.0	—19.0	11.7	9995	13.9	— 3.8
Betelgeuse	α Orionis	166.6	— 9.3	*0.70	—3.9	83.0	—13.0	82.0	10077	11.1	— 9.9
Agena	β Centauri	278.5	+ 2.0	0.86	—3.7	83.0	+ 2.9	83.0	9943	11.3	—21.2
Altair	α Aquilae	14.5	— 8.9	0.89	+2.5	4.9	— 0.8	4.9	9997	17.5	1.3
Austrina	α Crucis	257.0	+ 0.2	1.03	—3.1	67.0	+ 0.2	67.0	9976	11.9	—21.6
Aldebaran	α Tauri	147.8	—20.9	1.06	—0.4	20.0	— 7.2	18.8	10019	14.6	— 0.2
Pollux	β Geminorum	158.6	+22.8	1.21	+1.3	10.0	+ 4.0	9.2	10009	16.3	— 0.7
Spica	α Virginis	282.7	+51.6	1.21	—3.1	71.0	+55.0	44.0	9968	11.9	—10.4
Antares	α Scorpii	318.3	+15.8	1.22	—3.8	100.0	+27.0	97.0	9903	11.2	— 4.5
Fomalhaut	α Pisc. Aust.	345.5	—64.4	1.29	+1.9	7.7	— 7.0	3.3	9997	16.9	0.4
Arided	α Cygni	51.0	+ 1.7	1.33	— 5.2	200.0	+ 6.0	200.0	9983	9.8	68.5
Regulus	α Leonis	192.2	+48.8	1.34	—0.4	22.0	+16.7	14.7	10009	14.6	3.6

* (Betelgeuse) means m, M, ± 0.6.

In conclusion, it should be remarked that our first magnitude stars would by no necessity be recognizable as portrayed, seeing that the countless other stars in between (and now mainly invisible to us) would fill up the foreground of our new viewpoint, not to mention many stars nearer the galactic centre, that would constitute the first-magnitude array for any eyes there to see them.

MAY, 1941.

Marvelous Voyages—V

ERRORS IN WELLS' THE FIRST MEN IN THE MOON

By LAURENCE J. LAFLEUR

1. It is generally believed that the action of gravitation is instantaneous at any distance and unaffected by an intervening substance; and this view is supported by all available evidence. For example, the tidal pull of the farther side of the moon is felt on the farther side of the earth through the diameters of both bodies. Whether our present beliefs are true or not, it is at any rate certain that in past or present physical knowledge there is nothing that could indicate to Cavor the possibility of a substance impenetrable to gravitation.

2. If there were such a substance it could still be taken for granted that the fundamental laws of the constancy of energy would remain unimpaired, and a machine which could perpetually deliver energy without

an external source would be no less impossible with Cavorite than with any known material. If Cavorite acted as described by Wells, such a machine would be possible merely by placing Cavorite under one side of a vertical wheel.

In consequence, we must assume that Cavorite would throw a "shadow" in the field of gravitational potential, so that a circular sheet would throw a squat cone of gravitational umbra upwards, surrounded and covered by an inverse cone of penumbra. To move an object from outside the penumbra to inside would require as much work as to move it an infinite distance from the earth, and no gun has been built which could throw a projectile through the penumbra. The force of g, acting outwards from the cone, would be enormous in the vicinity of the sheet of Cavorite, so that space itself, in the thin penumbra above the sheet, would be harder and more impenetrable than any solid we know. Furthermore, any object in the penumbra would be projected from it with enormous violence.

3. It follows that the air above the sheet of Cavorite would not spout upward and exhaust the earth's atmosphere: on the contrary the air would be projected from above the sheet into the rest of the atmosphere, negligibly increasing its density.

4. It follows likewise that to make a square foot of Cavorite in a horizontal position would require energy enough to lift a ton an infinite distance from the earth. No such energy was supplied in the story.

5. Similarly, to unroll Cavorite or to move it from a vertical to a horizontal position would entail the amount of work necessary to exhaust laterally the atmosphere above it. To move the Cavorite laterally would involve overcoming the same resistance as would be encountered in moving a vertical wall as high as the atmosphere and as wide as the sheet.

6. To unroll the Cavorite screening the sphere from any celestial body would require work equivalent to removing the sphere an infinite distance from such a body.

7. Even rolled up a sheet of steel has area, and would have the same effect on the atmosphere which a smaller unrolled sheet would have.

8. Helium is not known to combine with any substance, and there is reason to believe that it cannot be combined. Hence it cannot be specifically necessary for the manufacture of Cavorite.

9. An electric heater would be highly inefficient for use in the sphere. Where is the current to come from? As combustion is out of the question, a chemical heater would seem to be indicated.

10. Assuming, as Wells does, that the sphere would be forced upwards by atmospheric pressure, its initial acceleration would be about 678 feet per second, less atmospheric friction and interference (this and other figures depend upon the assumption that the radius of the sphere

is 6 feet, free apparatus within the sphere weighing, with the travellers, 1000 pounds, and the total loaded sphere having a density of .1). Evidently there would be much more than "a little jerk."

11. With the sort of preparation that Verne suggested for his cannon, the voyagers might survive the shock of departure: without it they almost certainly would not. It is preposterous to suppose that Bedford could be ignorant of the departure.

12. Acceleration would continue, at a reduced rate, until the sphere was beyond the atmosphere. The pressure would not, therefore, "last for an infinitessimal time," but would pass away gradually over a period of a number of seconds.

13. It would take a few seconds over an hour for objects to fall a foot towards the center; not a few minutes. If the men are the major free weights, the period would be nearer two hours than one.

14. If the opening of four windows does in fact enable the moon's gravitation to act upon the whole sphere, the moonward acceleration of the travellers would be no greater than that of the sphere and they would fall towards the center as before. If less than one hemisphere were open, however, the pull on the sphere would be less in proportion to its mass than that on the travellers, and the reported phenomenon could occur. In this case, of course, lunar gravitation would not be acting upon the whole sphere.

15. Navigation of the sphere in such a way as to produce a landing with nothing more than a jar is a theoretical possibility (granted Cavorite). But the calculations necessary to make this possible would puzzle a mathematician with unlimited time at his disposal. Yet we are to picture Cavor as doing this in the intervals of snapping windows open or shut.

16. Opening a window not precisely facing the center of mass of an available celestial object would impart to the sphere not only a linear acceleration but also a rotary motion, not mentioned in the story and apt to be unpleasant.

17. Every movement of the travellers would impart a spin to the sphere, and we should expect this to be mentioned.

18. In view of the two factors producing spin, it would be practically impossible for Cavor to open a window which should be opened according to his calculations. This condition would be remedied if a gyroscopic compass were carried, but there is no suggestion to this effect.

19. Frozen air would not be snowlike: it would not condense from the gaseous directly to the solid form.

20. In a glass sphere partially imbedded in a bank of frozen air the travellers would quickly have perished of cold, regardless of the electric heater.

21. The heat of the sphere would cause the frozen air to boil immediately.

22. Purple shadows and blue sky are produced by a dense atmosphere and obscuring material. They are not to be expected on the moon, even if a certain amount of atmosphere were present.

23. Whatever atmosphere may exist on the moon has escaped observation. It could not be sufficiently dense to support human life.

24. Gravitational pull has little effect upon vegetable growth. Notice that a tree trunk does not grow upward much more slowly than a limb grows outward; creeping plants are not particularly fast growing; and roots do not grow downward with an acceleration due to gravity.

25. The mass of the moon is approximately an eightieth part, not an eighth part, of that on earth. The error, incidentally, is not peculiar to one edition of the book.

26. A lichen is an unfortunate choice as a protype of lunar vegetation. Its nature is so remarkable that it is less likely to have its type repeated than almost anything else that might be suggested.

A View of Time

By RICHARD SCHLEGEL, Jr.

In this essay we propose to talk about time as a component of the world. We are interested in asking what time is, and whether or not it is found everywhere in the universe. The subject is, admittedly, rather frightening, and of the sort, people say, which makes their heads spin. But, in the belief that the awesomeness of time is due more to the way it has usually been discussed than to the subject itself, we shall hope to talk about it with a minimum of vertigo.

We can begin by saying that time is that something by virtue of which one event is earlier or later than another. This is a definition of time as it comes into our every-day life. And it is here that we want to start: with what has been called "psychological" time, in contrast to the time which is some universal thing apart from our direct experience. In a world which totally lacked clocks or any formal division into units of time—into years, days, minutes, etc.,—we would still have this experience of events having the relation of earlier and later amongst themselves. This experience can be expressed as a psychological consequence of our possessing the faculty of memory. We remember an event as having already happened, and it therefore is before, or earlier than, an event now happening. And because we can remember sequences of events, we say that we order events in time, that is, arrange them in order of occurrence. But it is important to notice that "psychological" time based on memory of events alone would differ among individuals. It will be readily admitted that a space of an hour may under certain circumstances seem like but a few minutes, and again at other times seem almost endless. One person will speak of the day as

having flown, while another complains that it dragged. Time, then, is continually presented to us in psychological experience, but not as a neat series of similar units. For constant units of time man looks outside of himself, to the natural world; and there he finds cyclic events, upon the moment of occurrence of which all men will readily agree.

The basic regularity in nature to which men first attended probably was the succession of day and night. Consider two points in that cycle, sunrise and sunset. These are events upon the moment of occurrence of which all the individuals in a given locality can roughly agree. Between sunrise and sunset, although all would have the common experience that one is later than the other, there would be considerable variation in subjective feeling about how much later the sunset was after the sunrise. But the fact that all agree when the moment of sunrise or sunset is occurring, seems to give some objective measure of time. And the pervading character of the events, *e.g.*, the obvious change from day to night, or *vice versa*, carries the feeling that here is a universal time measure, in contrast with which men's varying subjective impressions of time seem trivial, as one man or woman is trivial against the world.

Our customary divisions of time are based, of course, not only on the daily rotation of the Earth, but also on the Earth's yearly revolution about the Sun and on the phases of the Moon. These are the regularly occurring events which men first used as objective reference background for their individual impressions of the duration between some two events. We today employ a variety of devices for our time measurement. Vibrating pendulums, stretching and contracting springs, and pulsating electric currents are probably the most common mechanisms for our clocks. These mechanisms are cyclic events, having as an advantage over the astronomical cyclic events the fact that they occur many times to one occurrence of an astronomical cycle, and therefore can be used as a measure of much smaller units of time. Thus, a pendulum adjusted to swing 86,400 times during one axis-revolution of the earth can be used as a measure for our "second."

It is of significance that all of the various cycles which we use as our time measures are mutually consistent. That is, they bear a constant relation to each other: the swing of the properly adjusted pendulum is regularly 1/86,400 of the duration of one rotation of the earth; each of the daily rotations measures an equal number of some other type of cyclic event, as, say, the electric pulsations of a uniformly rotating dynamo. There is no need to multiply illustrations. To mark our units of time we have a wide number of interlocking cyclic events, some of them obviously presented in nature, others ingeniously devised by man from nature. The cycle of events seems to be everywhere in nature. We find it among the astronomical bodies, with their regular motions, and among atomic phenomena, where, for instance, the atoms uniformly emit their tiny quanta of energy to form wave-radiations of absolute

regularity, such as light rays. That we find among these different cycles complete consistency of relation indicates that the cycles of a given type are regular or uniform with respect to each other. Were this not so, men would not have been likely to find regularities against which to place their experiences. Nature would then seem to have the same variation of things happening slowly or rapidly that men find in their own subjective experience. But, since the natural world is pervaded by things occurring in regular cycles, men have come to consider time, when they think of it as being apart from their direct awareness, as being something which is divisible into equivalent intervals.

We shall later see that the non-cylic aspects of nature are also of great importance to the problem of time. But for the present, we find that two elements seem to form the time concept: our consciousness of events having relations of earlier and later to each other, and the obvious presence of recurring, uniform cyclic phenomena in the natural world. The second of these elements is a fact of nature, which we accept as an indication of the nature of the world. The first of the two elements similarly tells us something about the universe: namely, that there is an "apartness" of events, that they do not all happen to us at once, but are separated. "Separated in time," as we say. It is this fact of events occurring at different moments, of not being presented to our consciousness all at once, which seems to have disturbed people most in their thinking about time and to have given rise to the various notions of a mysterious "time-entity" of some sort which carries us from event to event. However, if we wish to avoid speculation with words which lack any significance in terms of experience—and this writer does wish to avoid such speculation—we need not worry about such entities. We simply have the fact before us: that events are separated, not only in place, but also in moment of occurrence. The scientist knows that in his investigations of nature he eventually comes to a point where he no longer asks "Why?", but instead simply states what he finds. In other words, there are certain broad aspects of nature which we accept as being the way nature or the universe is, since we have no tools with which to ask fruitfully, "Why is this so?". Thus, we find that the world is extended in space, that matter has breadth, length, depth, and let it go at that. Similarly, we must accept that events do not happen all at once; that any two events are usually experienced at two different moments.

This apartness of occurrence of events is, I suppose, the basic element in our notion of time. The function of natural cycles in standardizing our time has been discussed. But there is a third element, without which we would never have arrived at our time concept. This element is the presence in the world of progressive change. In a sense, we have change when we have cyclic phenomena, for a cycle of events is a recurring pattern of changing circumstances. But our third element requires change that is "really" change—not just a cycle of events always re-

turning to its starting point, but a series of events that progressively changes something, that is continually causing something to be different. The most obvious example that man has of such a progressive change is his own life. From birth to maturity, thence to senility and death, man is continually becoming something he was not before. And similarly, of course, the animals and plants have their progressive changes from birth to death.

It is because of this element of change that we think of time as "moving forward," of always bringing a tomorrow that is different from today. For without differences between events there would be no distinguishing between them. If the only changes presented to man were recurring cycles, there would probably be a sense of time within the cycles: that is, one event of the cycle would be at a different moment from another. But each cycle would be like every other, and there would be no justification for considering any one cycle to be at a different time from another. If man and the other living things remained constant, and the only change was the cyclic one of day to night and season to season, there would be no point of looking forward or backward, for future and past would not be different from the present. If each day and year were exactly like every other day and year, one could only find variation within the day cycle and the year cycle. There would be no justification for considering any one year as different in time from another; nor indeed, would there be the slightest impulse to make such a distinction between the years.

At this point the reader may exclaim, "perhaps so, but still in reality one year would be later than another, even though there were no changes, no differences, between the events of any two yearly revolutions of the earth." But here you are betrayed by your particular human situation. For mankind there is every reason in the world to distinguish one year from the other, for not only our own selves, but our society, other living things, and to some extent the earth itself, changes from year to year. We can very properly speak of time as moving forward, because we see progressive change everywhere about us. But we have no right, therefore, to generalize, and say that throughout the universe there is time, "flowing equably from its own nature." We can serially order events according to a "later than" relation because of the natural fact that we find progressive changes in our world. And the "because" in the preceding sentence should be emphasized; if we did not find progressive change, we would have no notion of time's "irrevocable forward movement." Here again, then, our concept of time is resting on a natural fact. That we human beings do live in a world of change is a matter of supreme importance to us. But this natural fact about ourselves and our immediate environment certainly does not warrant the conclusion that there is a constant sort of progressive change throughout the universe.

We began our discussion by saying that time is that property by means of which we determine relations of earlier or later among events. This was a rough, denotative definition, which served the purpose of identifying that about which we were going to talk. But we can now give a more meaningful definition: time is consciousness of change, measured against a background of uniformly cyclic events. We can see from this definition that the time concept arises because of certain conditions in nature. Since we are conscious beings, we are aware of events; we experience different events, for the world around us changes, is not ever the same. Possessing memory, we compare these events, those happening now with those that have already happened. Some of the events occur over and over again, at regular intervals; those we use to mark the great variety of unexpected, irregular events. Our time-keeping is a tallying of cyclic events against the non-cyclic events of an irregular but progressive change. Thus, how many times does the Earth go around the Sun as some one person goes through his life, or while a tiny slip grows to a magnificent tree. We are aware of change, and compare it with regularities. Time is one aspect of our consciousness of nature, and a very useful one. By reference to the regularities we can compare irregular patterns of change: the lengths, say, of two men's lives. Or, by reference to some one point in a cycle, we can arrange for certain events to occur at that point in the cycle: for two friends, say, to meet at sunset, or for a crowd to gather at a hall when a clock indicates eight o'clock. The almost world-wide synchronization of clocks and calendars in reference to common astronomical cycles gives us, of course, our practical regularities by which to measure the ever-changing aspects of the social and natural world.

Armed with the definition of time given above, we can now consider the question of the universality of time. This question becomes one as to what the universe as a whole is like. Do we find everywhere those natural conditions which have brought about the notion of time in our particular part of the universe? We cannot answer this question, for our astronomy and physics are far from giving us a complete picture of the universe. But we can speculate upon what probably are the alternative answers.

Our definition of time begins with a reference to consciousness. That is easy, and we have no trouble here about universality, for we quickly assume that it would be theoretically possible for a human observer to visit or to know every part of the universe. The important problem is that of the universe as a whole in relation to progressive change, or lack of it. We will assume that there are events of some sort happening everywhere in the universe. Now these events—this change of things—may basically be of the cyclic sort. We know there is non-cyclic change in our own part of the world, but it may well be that pervading the universe is a uniform, recurring cycle of events: some grand pattern of

the heavenly bodies, ever repeating itself, or perhaps some basic rhythmic throbbing on the atomic level. Whatever the cycle might be, it would imply that for the universe as a whole there is not time, as we know that concept. For without progessive change of some sort, we do not have time. As we have already pointed out, if the only change is that of uniformly recurring cycles, there is time only in the degree that there is change within each cycle.

On this hypothesis, then, the universe is basically timeless. If the reader will imagine himself out of his own time situation, he can readily see that if the universe is a series of cycles, each of which in its broad outline is like every other, there is no justification for distinguishing any one cycle from another. I use the term "broad outline" advisedly. Certainly within the events of a basic cycle there is non-cyclic change, for example, the changes in our own little world. But if the basic, inclusive pattern of the universe is cyclic, then, to repeat, the universe is basically timeless. Time, then, would become an attribute found only among the more complex series of events which take place within the framework of the general basic cycle. Thus, the solar system would be a series of events presenting change; and particularly on our earth would there be the progressive change which gives rise to time. Living things, with their high degree of complexity, would especially involve non-cyclic events. Man, then, would be a representative of a small group of organisms or "event-patterns" which have the property of time— that is, of progressive change—but live in a world which is essentially and basically timeless.

It is essential that the universe possess a basic regularity of cycle if we are to have an "absolute time system" of the sort posited and employed by the Newtonian physicists and astronomers. Such a system implies that "time is everywhere the same," that we can state whether two events in different parts of the universe are happening at the same time; or, if not, how much time has elapsed between the events. Now what is actually implied here is that there is some sort of regularity to which we can refer all other events. In a limited fashion we have such a regularity for events occurring in our terrestial environment; the motion of the earth gives a cycle to which we can refer those events. It no doubt was by a generalization from this situation that the seventeenth century scientists arrived at their notion of absolute time. But this generalization is valid only if there is some universal, pervading cycle to which all events can be referred. So we see that it would be only the basically timeless universe which possesses "absolute time." For if there is to be an "absolute" universal cycle against which to measure whatever changes we observe, then the universe must be essentially cyclic and unchanging rather than progressively changing.

It seems to me, however, that in the light of our present knowledge the hypothesis of a basically cyclic universe is somewhat improbable.

Many of the recurring cycles which we find in nature are not altogether uniform, but are decreasing or increasing their tempos. Thus, we have here been discussing the Earth's rotation as if it were something absolutely unchanging. Astronomers surmise that the period required for the rotation of the Earth may be becoming just a trifle longer year by year, as measured in relation to other even less variable cycles. Indeed, there is no reason to think that any of the astronomical cycles are unchanging; rather, our physics and astronomy definitely indicate the contrary. And throughout as much of the universe as they can explore, astronomers find evidence of continual, progressive change. Certainly, for instance, a system of Suns and encircling satellites slowly changes as a system. Or, to go to the realm of living things for an example, we find a recurring life cycle amongst a given species of animals or plants, and also a slow, evolutionary change of the species itself.

Our alternative hypothesis, of a universe which is pervaded by a progressive or non-cyclic change, gives us a universe which possesses time as an essential attribute. Such a universe would presumably have a beginning and an end: some point at which the progressive change began, and a point at which it ended. I think a universe of this sort is the more appealing emotionally to mankind. It is pleasant to think that the changing world that we know is in some fashion consonant with the universe as a whole. To think of our interesting, complex natural world as a somewhat unusual occurrence in a universe basically cyclic and unchanging is a rather chilling thought; it is much more satisfying to think that our changing and often trying world has some meaning in terms of a continual change, or of a progress, in the universe as a whole. The relativity theory of Einstein indicates that the contemporary tendency among theoretical physicists and astronomers is to think of a universe which is not pervaded by a cyclic change. The relativists make just the point that time has meaning only as it is a measurement of change with reference to some given cycle or clock, and they assume that we shall not find any one such cycle or clock anywhere in the universe.

But whatever the case may be, whether the universe is basically cyclic or non-cyclic, we cannot state the answer here. It is a question for the scientist to answer; and some day he may have sufficient knowledge about the universe to indicate positively whether it is fundamentally cyclic or not. What we have tried to do, is to make the important point that our time concept is determined directly by the natural world around us. And the fundamental questions about time are to be solved by our investigations of nature.

707 West Nevada Street, Urbana, Illinois.

The Planets in March, 1943

By ALICE H. FARNSWORTH

NOTE: Greenwich Civil Time is used unless otherwise stated. To obtain Eastern Standard Time subtract 5 hours; Central Standard Time, 6 hours, etc. War Time in each zone is one hour later than Standard. Phenomena are described as seen from latitude 45° N. *The American Ephemeris and Nautical Almanac* is the source of most of the data.

Sun. The Sun, in moving from the constellation Aquarius (α 22^h 44^{m}4, δ —7° 59'.9 on March 1) into Pisces (α 0^h 38^{m}2, δ +4° 6'.9 on April 1), comes northward with maximum rapidity, 12° in a single month. It arrives at the Vernal Equinox and is overhead at Earth's equator at 12:03 Sunday, March 21, marking the beginning of spring for the northern hemisphere, the end of summer for the southern. On March 27 the Sun occupies the exact northwest corner of Cetus where that constellation meets but does not cross the ecliptic.

Moon. The New Moon in February eclipsed the Sun just before reaching the descending node of its orbit; this one passes the node more than a day before its conjunction with the the Sun and slides by slightly to the south without encroaching at all on the Sun's disk. There will be no possibiliy of any more eclipses until August when the New Moon will reach the opposite node.

The First Quarter Moon graces Taurus and the region of brilliant winter stars and planets, a sign that winter is well on its way out and spring close at hand. Full Moon occurs 10 hours and 5 minutes after the Sun crosses the equator. Evidently this is a year when the simple rule for Easter (as being the first Sunday after the first Full Moon after the Vernal Equinox) does not work.

The phases and other phenomena occur as follows:

	d	h	m
New Moon	6	10	34
First Quarter	13	19	30
Full Moon	21	22	8
Last Quarter	29	1	52
In Perigee	4	7	
Runs high	15	4	
In Apogee	16	2	
Runs low	29	4	
In Perigee	31	17	

This is a good month to study objects near the limb of the Moon with the telescope because favorable presentation keeps pace with illumination by the Sun. The 5-day cresent on March 11 shows well the western *maria:* Australe, Smythii, and Marginis; the spotty Spumans and Undarum, Novum just off Plutarch, and Humboldtianum looming up beyond Endymion. As well seen as possible are the ever-foreshortened walled plains, William Humboldt, Hekataus, Neper, Gauss (like a paramoecium) and others. Objects north of Plato are also well treated at this time.

By March 24 the 18-day Moon has lost the blinding radiance of the Full Moon in the telescope and is letting us see farther than usual around its east limb: Grimaldi moves over until its center appears more than twice the crater's width from the limb. The knobby limb formed by the Corderillas and D'Alembert

Mountains is evident, and the little-known *maria* of the seasons (Aestatis, Autumni, Hiemis, and Veris) are in position to be identified. Plate X among the marvellous photographs in the recent Lick portfolio shows what to look for. A day or two later the numerous walled plains huddled together beyond huge Clavius in the south portion are best seen, with the Moon at a comfortable altitude.

Mercury is west of the Sun throughout the month, trailing it across Aquarius, too close to it to be observable.

Venus, visible in the west as evening star, sets two hours after the Sun on March 1; the interval is nearly doubled by the end of the month. The crescent Moon passes a few degrees south of the planet on March 8.

Mars is the morning star all spring. It rises two hour before the Sun but remains low in the southeast in Capricornus. Twice during the month (March 3 and 31) the waning crescent Moon overtakes it, passing by to the north.

Jupiter, stationary on March 12, lingers during the month in a position just west of δ Geminorum, within two degrees of the position in which Pluto was discovered in 1930. It is in ideal location for telescopic study of surface details. Especially rewarding satellite phenomena occur on the nights of March 1-2, 8-9, and 17-18.

At this time when Jupiter is so near east quadrature that its east-falling shadow makes a considerable angle with the line of sight to the planet, Satellite IV (the most distant of the Galilean four) enters the planet's shadow a good 6 to 8 hours after emerging from occultation. Its reappearance from the shadow 4 hours later takes place at a point more than two planet-diameters east of Jupiter. Watch for this at 2:58 on March 2.

On the nights of March 4-5, 18-19, and 25-26, the four satellites are all on the east side of the planet.[1]

The Moon arrives in the planet's vicinity on March 15.

Saturn moves slowly eastward north of the Hyades in Taurus, covering 2° during the month. The Moon, south of it on March 12, passes through the Hyades.

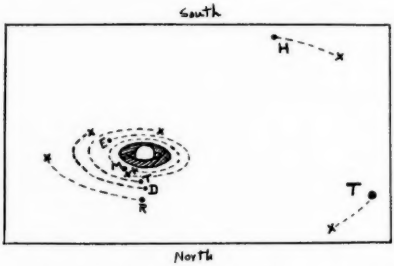
Telescopic detail visible in the wide-open rings is confined to the divisions in the rings: Cassini's (named for the first Director of the Paris Observatory, discoverer of four moons of Saturn) between the outer Ring A and the brighter Ring B, and Encke's which lies in Ring A and is harder to see. Apparently in these narrow empty zones none of the myriad tiny bodies which we suppose to constitute the rings are permitted to remain. If present, for example, in the position occupied by the broad Cassini's division their periods of revolution around Saturn would be commensurable with those of Mimas, Enceladus, and Tethys. These more massive moons would thus have frequent chances to throw the tiny bodies off their course. Encke's division and others still more difficult to see, may be attributed to the action of Mimas.

"The rings reflect light excellently, better than natural rock surfaces. Material

[1] On February 20-21, the night after the partial eclipse of the Moon, at 2:35 all four of Jupiter's satellites are visible close to the planet. Twenty minutes later, by 2:55, only Satellite IV remains (I and III having entered transit at east side of disk, II having disappeared into occultation on the west side). This situation lasts until 5:10. After 3:48, the shadow of Satellite I is on the disk, crossing from east to west. Not until 6:14 does the slow-moving Satellite IV enter transit.

generally reflects better when pulverized than when in large pieces; therefore the particles of Saturn's rings are probably small, like ordinary dust."[2]

Now that the rings are wide open, a clear view of the planet's equatorial region is given for detection of bands or other surface details. In this respect the planet falls far short of Jupiter in interest. Possibly its lower temperature (—243° F as compared with —216°) may explain "the more sluggish changes in the cloud formations and less complex structural detail."[3]



Dots show positions of satellites of Saturn on March 18 at 0^h, G.C.T. Identify by initial letters: Titan and Hyperion far out; Rhea, Dione, Tethys, Mimas, and Enceladus near the planet. Crosses indicate positions 24 hours later.

Titan, Saturn's brightest moon, is bigger than Earth's Moon and is easily seen in the field of view of the telescope, looking like a star of the 8th magnitude. It was discovered by Huyghens at about the time when he published his anagram indicating that he was aware of the true form of the rings. With the aid of tables and charts given in *The American Ephemeris*, three or four other individual moons of Saturn observed as tiny pin-pricks of light close to the planet can readily be identified. At present the orbits are projected on the sky as wide ovals, and the moons appear above and below Saturn in each clock-wise revolution. In the figure, the dots show the expected positions of the satellites on March 18 at 0^h, and the crosses their positions one day later.

Uranus moves eastward in Taurus one degree during the month. Its path is shown on the chart in POPULAR ASTRONOMY for January.

Neptune, being now very close to the Autumnal Equinox, comes to opposition on March 22, seventeen hours after the Sun reaches the Vernal Equinox. Three days before, the planet will pass within 1′ of arc of a catalogue star (BD + 1° 2656) of almost the same brightness as itself ($7^M.7$). This offers an excellent opportunity to find whether in your telescope the planetary image differs visibly in quality from a stellar image.

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[2] Quoted from Fred L. Whipple's "Earth, Moon, and Planets," p. 179. The Blakiston Co. 1941.

[3] *Ibid.*, p. 180.

Asteroid Notes

By HUGH S. RICE

None of the larger and brighter asteroids is available for observation with small telescopes at the present time. However, it happens that the "Big Four" as well as a few of the other rather bright ones will be in good position later in the year. Juno is the first of these to come to opposition—in July, and most of the others will be most favorably placed in the autumn. Early this spring, therefore, Juno will be ready for observation as an object in the morning sky before sunrise. We expect soon to offer ephemerides and directions with which to locate the planet. Then it will be followed by Iris, Pallas, etc.

It is often of interest to students of astronomy to know the periods of the asteroids around the Sun. The periods of most of them do not appear to be available in a list, so that we are giving herewith a list of those that have the shortest periods, and a list giving those with the longest periods. Ordinarily the technical data are given as the number of seconds of arc, μ, in the daily motion. From these data we have derived the subjoined table. The daily motion, μ, is equal to 360° divided by the number of days in the period; hence the number of days in the period is equal to 360° divided by the daily motion. Our original data of daily motion are taken from the Coppernicus-Institut at Dahlem, and were given in 1940, so that the resulting values are at least approximately correct.

Shortest Periods		Longest Periods	
Asteroid	*Period in years*	*Asteroid*	*Period in years*
... Hermes	1.47	944 Hidalgo	13.97
433 Eros	1.76	659 Nestor	11.97
... Apollo	1.81	884 Priamus	11.97
1355 1935 HE	2.52	588 Achilles	11.90
1453 Fennia	2.61	1172 Aneas	11.86
1235 Schorria	2.64	1437 Diomedes	11.85
1019 1924 QN	2.64	617 Patroclus	11.84
1221 Amor	2.66	1143 Odysseus	11.77
1103 Sequoia	2.69	1208 Troilus	11.73
434 Hungaria	2.71	1404 Ajax	11.66
1139 Atami	2.72	624 Hektor	11.64
... Adonis	2.76	911 Agamemnon	11.62
1025 Riema	2.78	1173 Anchises	11.49
330 Adalberta	3.02	279 Thule	8.76
1095 Tulipa	3.16	1345 Potomac	7.92
722 Frieda	3.20	153 Hilda	7.90
244 Sita	3.21	1162 Larissa	7.90

Hayden Planetarium, American Museum of Natural History, New York, New York, January 18, 1943.

Occultation Predictions for March, 1943

(Taken from the *American Ephemeris*)

The quantities in the columns a and b are given for the purpose of making these predictions useful for any place within 200 miles of the point indicated. The procedure is as follows: Subtract the longitude of the point given from the longitude of the place in question; multiply the result in degrees, taking the signs into account, by the quantity under a for the star to be observed; similarly,

with the latitude, using b; apply the sum of the products, with its proper sign, to the Greenwich C.T., and obtain the predicted Greenwich Civil Time for the phenomenon at the place of observation. To obtain Eastern Standard Time it is necessary to subtract five hours; Central Standard Time, six hours, etc.

Date 1943	Star	Mag.	IMMERSION Green-wich C.T.	a	b	Angle E from N	EMERSION Green-wich C.T.	a	b	Angle E from N
			h m	m	m	°	h m	m	m	°
Occultations Visible in Longitude +72° 30′, Latitude +42° 30′										
Mar. 1	39 G.Sgr	6.3	9 4.2	—1.4	+1.9	66	10 4.1	—1.0	—0.1	311
11	BD+11° 445	5.9	1 23.5	—0.5	—1.6	99	2 22.7	—0.3	—0.3	236
13	318 B.Tau	5.7	4 16.2	0.0	—1.4	96	5 13.6	+0.2	—1.0	260
17	ζ Cnc	5.1	0 1.5	..	..	29	0 31.7	..	..	349
17	o^2 Cnc	5.6	21 3.8	—0.4	+1.4	94	22 13.6	—0.9	+1.0	280
25	13 Lib	5.8	3 13.7	—0.5	+0.5	116	4 19.4	—0.9	+0.6	290
Occultations Visible in Longitude +91° 0′, Latitude +40° 0′										
Mar. 11	BD+11° 445	5.9	1 11.8	—1.2	—2.1	111	2 11.1	—0.9	+0.8	219
12	179 B.Tau	6.0	4 39.9	0.0	—1.3	95	5 36.8	+0.2	—0.7	253
13	318 B.Tau	5.7	4 17.8	—0.3	—2.2	119	5 13.7	—0.5	—0.3	236
16	ζ Cnc	5.1	23 22.9	..	..	37	0 6.3	..	..	332
23	65 Vir	5.9	10 57.3	—1.1	—1.2	90	12 1.8	—0.6	—2.2	312
23	66 Vir	5.8	11 44.4	—0.6	—1.7	116	12 47.3	—0.3	—1.6	283
27	29 Oph	6.4	11 55.7	—1.9	—1.2	120	13 9.1	—1.6	—0.6	255
Occultations Visible in Longitude +120° 0′, Latitude +36° 0′										
Mar. 12	179 B.Tau	6.0	4 37.3	—0.8	—3.2	130	5 25.7	—1.1	+1.3	214
17	d^2 Cnc	6.2	8 11.5	..	..	44	8 44.5	..	..	351
18	81 Cnc	6.4	5 43.3	—2.6	+0.2	84	7 4.3	—1.4	—2.8	318
19	ν Leo	5.2	3 19.6	—1.8	+2.4	70	4 26.8	—1.7	—2.1	326
23	65 Vir	5.9	10 17.3	—1.7	—1.5	125	11 38.8	—1.7	—1.5	289
23	66 Vir	5.8	11 21.1	—1.3	—2.2	142	12 30.2	—1.6	—1.2	269
27	29 Oph	6.4	11 12.5	—1.0	—1.7	154	12 6.5	—2.8	+1.6	236

METEORS AND METEORITES

Meteor Notes from the American Meteor Society

By CHARLES P. OLIVIER, President

Two reports have arrived dealing with Quadrantid meteors which appear early in January. The first is from R. M. Dole of Cape Elizabeth, Maine. For 1943 January 2/3, from 12:00 to 3:00 (E.S.T.??, record incomplete), he plotted 8 meteors. An inspection of his map indicates that 6 were Quadrantids, 2 were sporadic. I have projected these 6 paths and find a radiant: A.M.S. No. 4115, $\alpha = 213°$, $\delta = +49°$. This night was very clear and cold, factor hence assumed 1.0, and there was only one meteor as bright as magnitude 2. He reported January 1/2 and 3/4 cloudy at his station. The second report is from Bill Liller, Atlanta, Georgia, who observed on January 2/3 from 14:07 to 16:08 E.S.T., F = 0.9, plotting 14 meteors, and on January 4/5 from 14:15 to 16:00 E.S.T., F = 1.0, plotting 7 meteors. On the first night at 15:32 he observed a fine —2 magnitude blue meteor leaving a 4 second train, and on the second at 14:54.7 a —3 white-red meteor leaving a 3 second train. The first, quite distant from the radiant, was almost certainly a Quadrantid, the second was probably so. I regret to say that no accurate radiant can be derived from the plots as he observed parts of

the sky very far from the radiant. Under these circumstances we have found that the transfer of a path's projection over two or three intervening maps introduces such errors as to make the resulting radiants uncertain. Yet in this case his work, both plotting and recording, seems to have been done well. I hope that other reports on the Quadrantids may yet come.

Fireball of 1940 March 22/23

A brilliant fireball was seen to fall to the west of Detroit, Michigan, at 7:22 P.M. (E.S.T.?) on this date. The only observation from which coordinates of the path could be deduced was that by Mrs. Margaret Beck, who gave $a = 105°$ to 110°, $h = 45°$, almost vertical path, but slightly to south, duration 4 seconds, and "nearly to horizon." One other observer at Cass City, Michigan, states that "it fell nearly straight west of me." The other observers are too vague for their directions to be of any use. We can only conclude that the fireball fell over western Michigan, probably near Grand Rapids. The object was orange or white at first, turning to red near the horizon. It did not explode. However, the important thing about it was that it left a train of smoke, in the clear twilight sky, that lasted from 3 to 15 minutes according to different observers. (It is No. 1294 of my list in Flower Observatory Reprint No. 60.) Data on such trains being of value, the actual words of observers are quoted. At Detroit ". . . blazed a trail across the sky for a period of 3 or 4 minutes." At Indian Hills: . . . streak of smoke that hung in the sky full 10 minutes." Two observers in North Detroit: ". . . streak . . . visible 10 to 15 minutes." The observer at Cass City mentioned no train; he was driving and probably inattentive. Phone calls to the Detroit *News* described it ". . . as a yellowish-red ball that left a white zigzag streak which remained in the sky for 4 or 5 minutes." The only description, accompanied by a drawing which gave an indication of the drift, came from Mrs. Beck. Her first note was ". . . falling with a long and heavy trail of white smoke which lasted about 5 minutes." Being asked for further data and a drawing, she consulted with two others who saw it and wrote ". . . we all agree . . . that the direction of drift was, at the finish, almost vertical in the S.W. direction, where the train lay in broken puffs of smoke." However, in attempting to interpret these words using the drawing, there are serious difficulties. From the latter one infers that the *lower part* of the train drifted horizontally from right to left, *i.e.*, to S. What happened to the upper and central parts is not clear. Probably the best conclusion is to use only the observer's very words that the lower part drifted to the S.W. The angular velocity, derived by scale from the drawing, indicates 2°+ per minute which is large indeed for such a low level. This figure is probably erroneous and the diagram was most likely not intended for such a use.

In conclusion, I beg again that all amateurs—or professionals—who have the good fortune to see such a train will take the time and trouble to make accurate notes. These trains are seen so seldom in an individual's life that the slight effort would be amply repaid. Only from accurate observations can the true drift be deduced and these latter are fundamental in studies of the upper atmosphere.

At almost the same hour, 7:20½ P.M., E.S.T., on the next night, 1940 March 23/24, a fireball, not quite so bright as Venus, green in color, was observed by C. R. Gregory from $\lambda = 76° 38'$ W, $\phi = 42° 47'$ N. It moved relatively slowly from W. into N.E. in a curving path, only 15° of which was seen. It disappeared about 10° above N.E. horizon. There was no explosion, no sparks, and no train.

Why one fireball will leave a long-enduring train, another none, is one of the many unsolved questions in the study of meteors.

Flower Observatory, Upper Darby, Pennsylvania, 1943 January 18.

Contributions of the Society for Research on Meteorites

Edited by **FREDERICK C. LEONARD**
Department of Astronomy, University of California, Los Angeles

President of the Society: LINCOLN LA PAZ, Department of Mathematics, Ohio State University, Columbus

Secretary of the Society: C. H. CLEMINSHAW, Griffith Observatory, Los Angeles, and Department of Astronomy, University of Southern California, Los Angeles

A Possible New Meteorite Crater in North Africa

By H. H. NININGER
Colorado Museum of Natural History, Denver

Under date of July 21, 1942, Mr. Orval M. Klose of Miami, Florida, wrote me concerning a peculiar crater which he had noted while flying over North Central Africa. He suspected it of being a meteorite crater. I replied, giving him some criteria by which to form a tentative opinion on the matter, in case he were fortunate enough to fly over the same region again, and urged that, if possible, he obtain photographs of the object. On November 23, 1942, he wrote again, sending photographs and stating that he, in company with Captain Eugene B. Fricks, had once more flown over the spot, which he designated as being in position "15° 06′ N. Lat. and 26° 15′ E. Long., which is about midway between the Barti Hills and the Meidob Hills. . . I can guarantee this location to be correct to within 5 miles."

The photographs are very poor (they are not suitable for reproduction), but, when examined in connection with Mr. Klose's comments, they *do* give one the impression that the crater's structure lends itself to a meteoritic interpretation. He states that the floor appears to lie several hundred feet below the level of the general terrane outside the rim.

The crater is described as being a mile or more in diameter, with a conspicuous rim. The rim shows unmistakably in the photographs, as does also the small lake at the center of the pit. The rim appears to be rather narrow for the size of the pit, but the photographs are so indistinct that this impression may be incorrect. If the formation proves to be a genuine meteorite crater, it will be the first so far discovered to compare in size and freshness with the great Barringer Crater (at Canyon Diablo, Arizona), for its rim and walls appear to be very steep and rugged.

I call attention to this report for the reason that it may stimulate others who are flying in the vicinity of the possible new meteorite crater to obtain more definite information about it in the form of good, clear photographs, etc., and perhaps even to visit it by land.

A "Possible Lunar Meteor"

Attention is called to the observation of a "Possible Lunar Meteor," reported by Walter H. Haas in a paper entitled "Does Anything Ever Happen on the

Moon?" (*Jour. Roy. Astron. Soc. Canada*, **36**, 397-8, 1942). Of interest in this connection is Dr. La Paz's illuminating article on "The Atmosphere of the Moon and Lunar Meteoritic Erosion" (*C.S.R.M.*, **2**, 35-40, 1938-41; *P.A.*, **46**, 277-82, 1938).—F.C.L.

Calculations on the Probable Mass of the Object which Formed Meteor Crater*

By C. C. WYLIE

The famous Meteor Crater, near Winslow, Arizona, is a cup-shaped, roughly circular, depression about 4000 feet in diameter, and 600 feet deep. The rim is raised about 150 feet above the surrounding country, and borings show that on the southwest, the rock is pulverized to a depth of 700 feet or more below the present bottom of the crater. Considerable meteoric iron in the vicinity, with other evidence, indicates that the crater was produced by the impact of a giant meteor.

The older estimates of the size of object which produced the crater were based on comparisons with holes made by stones dropped from a height into relatively soft earth. Some of these placed the diameter as about 3000 feet, and the weight as over three billion tons.

Other investigators calculated that the pressures developed when the meteor struck must have been a hundred times that necessary to crush rock or iron. They estimated the size of the object from the behavior of a ball of liquid or plastic material striking liquid or plastic material. The assumption that the meteor would flatten out as it struck permitted the assumption of a smaller object as the cause of the crater. Öpik,[1] in this way, estimated the diameter at from 250 to 350 feet and the mass at from two million to five million tons. Making liberal estimates of the mechanical energy necessary to produce the crater, he accounted for little more than one per cent of the energy of the meteor he assumed as responsible; and he offered no explanation for the disappearance of the other ninety-nine per cent of the energy of the meteor at the time it was stopped by the impact.

Moulton, Spencer, Wylie, and others[2] have reasoned from observation and from theory that the kinetic energy of a crater-producing meteor must be converted into heat at the time it is stopped by the impact. In general, the heat must be sufficient to vaporize nearly all the meteor, and much of the rock with which it comes in contact, producing an explosion equal to several times its weight of nitroglycerin. The explosion should be equivalent to that of an amount of nitroglycerin whose heat of combustion is equal to the heat generated by the impact of the meteor.

If one accepts this application of the principle of conservation of energy, the early estimates of the mass of the object which produced the crater are much too large. The impact of such a large meteor would be equivalent to firing a volume of nitroglycerin varying from a little less than the volume of the crater to many

*Presented at the 69th meeting of the American Astronomical Society, Evanston, Illinois, December 29, 1942.

[1] *Publications of the Astronomical Observatory of the University of Tartu*, Vol. 28, No. 6.

[2] *Contributions of the University of Iowa Observatory*, No. 5, page 175; POPULAR ASTRONOMY, October, 1934, Vol. 42.

times the volume of the crater. Since a single pound of nitroglycerin will blast out tons of rock, it is obvious that meteors of the estimated size would produce craters enormously greater than the one in Arizona.

The calculations of this paper have been based on the preceding application of the principle of the conservation of energy, and can be divided into three steps, as follows: (1) Estimate the amount of nitroglycerin required to produce a crater the size of the one in Arizona. This can be done by comparing the volume of the crater with the volume of craters produced by large mines or blasts. (2) Set the kinetic energy of the meteor, for various striking velocities, equal to the energy found in step (1), and solve for the radius of the spherical iron meteor which will give the correct energy for each assumed velocity. (3) Assuming various velocities for entrance into the atmosphere, solve for the retarding effect of the atmosphere, and for the velocity with which the meteor would strike ground. In this paper, steps (2) and (3) were combined to lessen the labor of computation.

For calculating the amount of explosive necessary to produce a crater the size of Meteor Crater in Arizona, data on two large mines of World War I, and data on craters produced in Iran by the Anglo-Iranian Oil Company were used. The first mine crater was of radius about 135 feet, and depth about 60 feet, and was produced by about 30 tons of explosive. The second mine crater was about 170 feet in radius, and 67 feet in depth, and was produced by 35 tons of explosive. The oil company reports that craters about 50 feet in radius, and 40 feet in depth have been produced by a charge of explosive of three tons, or a little less.

The type of explosive used in the mine craters was not known, but the heat of combustion was assumed the same as nitroglycerin, which probably is too high. On this assumption, the nitroglycerin required to produce a crater the size of Meteor Crater was calculated from the two mine craters as 2.86×10^8 pounds, and 1.88×10^8 pounds, respectively. As stated before, these figures may be a little high because of the uncertainty in the type of explosive. For the oil company craters, the explosive was known to be equivalent to about 50 per cent nitroglycerin, and from the size of the craters produced about 1.56×10^8 pounds would be required to produce a crater the size of Meteor Crater. Perhaps the oil company work should be given more weight, but for conservatism we have adopted a relatively high figure as the requirement for Meteor Crater,

$$2.5 \times 10^8 \text{ pounds of nitroglycerin.}$$

This is 125,000 tons, or more than 3000 times the amount of explosives used in the larger of the World War I mines. From the molecular weight and the heat of combustion,[3] the energy in ergs of this amount of nitroglycerin can be calculated as

$$9 \times 10^{21} \text{ ergs.}$$

The kinetic energy of a crater-producing meteor at the time of impact is $(1/2)mV^2$, where m is the mass, and V is the velocity at the time of striking. If a spherical iron meteor is assumed, m can be expressed as a function of the radius. For such a meteor, the relation between the velocity at the time of entering the atmosphere and the velocity at the time of impact[4] is $V = V_o/(1 + A)$,

[3] "Handbook of Chemistry and Physics," Chemical Rubber Publishing Company, Edition 26.

[4] *Contributions of the University of Iowa Observatory*, No. 9, page 285. POPULAR ASTRONOMY, May 1938, Vol. 46.

where V is the velocity at the time of striking, V_o is the velocity at the time of entering the atmosphere, and A is a function of the density of the atmosphere and of the variation in density with height, of the angle of fall, and of the density and radius of the meteor.

The kinetic energy at the time of striking can be set equal to the energy in ergs required for the production of Meteor Crater. The quantity $V_o/(1+A)$ can be substituted for V, and both m and A expressed as functions of r. When this is done, the following equation results

$$V_o r^{5/2} = (2.48 \times 10^{10})r + 7.82 \times 10^{13}.$$

This equation is in scientific units, the c.g.s. system. Many Americans prefer to think of the velocity V_o in miles per second, and of the radius of the meteor r in feet. In these units the equation becomes

$$r^{5/2} = (9.53 \times 10^{2})r/V_o + 10^{4}/V_o.$$

For any assumed value of V_o the preceding equation can be solved quickly for r, by successive approximations.

It is known that the spectacular meteors move in direct orbits,[5] in general similar to those of such asteroids as Adonis and Hermes. Probably the V_o for Meteor Crater was between 10 and 20 miles per second. The following table gives the results for certain values of V_o.

V_o miles	V miles	m tons	r feet
7	5.3	29,000	32.0
10	7.1	16,000	26.1
15	10.0	8,000	20.9
20	12.6	4,900	17.8

If we accept the results of the orbit work, which implies that the velocity on entering the atmosphere probably was between 10 and 20 miles per second, the diameter probably was between 35 and 50 feet, and the mass between 5000 and 15,000 tons.

University of Iowa, December 26, 1942.

[5] POPULAR ASTRONOMY, January, 1940, Vol. 48, p. 42; June, 1940, Vol. 48, p. 310.

VARIABLE STARS

Variable Star Notes from the American Association of Variable Star Observers

By LEON CAMPBELL, Recorder

The 1942 Novae: Zwicky's Nova Cygni 1942 appears to be following the course predicted for it, in that its light has increased again from minimum to magnitude 14 on its way to a secondary maximum, according to Harvard plates taken this month. The nova was seen on earlier plates as faint as magnitude 16.5 —plates of November 9, 12, and 28—at magnitude 16 on November 30 and December 5, while on January 6 and 7, it was of magnitude 14.5 and 14.3, respectively. On January 10 the nova was of magnitude 14.0. When these observations are plotted, it is readily seen that the observed increase in brightness has been gradual, strikingly similar to that of Nova Herculis 1934 at the same phase. It is difficult

to judge to what magnitude Nova Cygni faded, but it was certainly below magnitude 16.5. It will be of interest to learn to what magnitude the nova will increase on its second rise.

Observations of Nova Puppis during the early days of its greatest brilliance continue to be received, especially from South Africa where it was observed at the Harvard Station by Dr. Paraskevopoulos, at the Cape Observatory by R. P. deKock, and at Durban by A. W. J. Cousins, although none of these observers noted the presence of the nova prior to the discovery by Professor Dawson. A report from Carlos L. Segers of Buenos Aires, received December 17, contains a list of observations of the nova, the first of which was made on the same night the star was discovered by Dawson.

To date, somewhat more than 200 observations by 44 observers have been received, more than 100 of these observations having been made in the ten days immediately following discovery, and before the star had faded away to the third magnitude. There were at least a dozen independent discoverers, although some of the discoverers failed fully to recognize the star as a nova. Observations were obtained on every night but one during the first month. Early in January the nova had reached magnitude 6.5, with very little evidence of any fluctuations in light.

It is difficult to find a counterpart of Nova Puppis among the other novae, as far as form of light curve is concerned, and its light curve has been compared with those of at least twenty other novae. It bears some resemblance to the light curve of T Coronae Borealis, 1866, which underwent an increase to a secondary maximum after fading away from magnitude 2.0 to 9.7, but on the whole Nova Puppis seems to have a light curve peculiarly its own.

The R Coronae Borealis Variables: From most recently received observations by the A.A.V.S.O., R Coronae Borealis and SU Tauri are again on the decrease to minimum, after what was thought to be a real rise to maximum. Such a secondary drop is not unusual for these stars; in fact it appears to be a more or less regular feature, as shown in the diagram on p. 569 of POPULAR ASTRONOMY for December, 1942.

The SS Cygni Variables in 1942: Many of the SS Cygni-type variables have been under close attention during the past year, particularly SS Aurigae, U Geminorum, and SS Cygni. SS Aurigae passed through four well-observed maxima, one late in February, another late in April, a third in the middle of September, and a fourth in December, with possibly one or two missed between June and September when the star was unfavorably placed for observation. Of the four observed, three were of the long-type and one was of the short-type.

Only two maxima of U Geminorum were observed, one early in March, the other in the middle of September, both of the long-type. Doubtless one or two others were unobserved.

Five maxima were observed for SS Cygni, with a fair chance that none was missed. These occurred in January, March, May, August, and October, with intervals between maxima ranging from 60 to 75 days, an average of 64 days for the year.

The maximum observed in October marked the 330th which had occurred since visual observations began in 1896, and of these not more than one, at the most two, passed unobserved. Although during these years the cycle intervals

between maxima have ranged from 20 to 120 days, the average length of a cycle has remained at almost exactly 51 days. SS Cygni was at maximum early in January, after an interval of three months spent at or near minimum light.

PREDICTED DATES OF MAXIMUM

Design.	*Name*	*Date of Max.* m	d	*Max. Magn.*
0010*32*	S Scl	12	16	6.8
001755	T Cas	2	24	7.8
001838	R And	5	19	7.0
021143a	W And	5	13	7.5
0214*03*	*o* Cet	4	8	3.8
0228*13*	U Cet	6	14	7.6
023133	R Tri	3	26	6.3
		12	17	
0250*50*	R Hor	7	4	6.0
0432*63*	R Ret	4	26	7.7
0443*49*	R Pic	1	31	6.7
		7	25	
0455*14*	R Lep	2	26	6.7
050953	A Aur	4	21	7.8
0515*33*	T Col	5	14	7.5
		12	25	
054920a	U Ori	1	17	6.6
055686	R Oct	11	10	7.8
0617*02*	V Mon	6	30	7.1
0652*08*	X Mon	2	14	7.6
		7	20	
		12	23	
065355	R Lyn	2	16	7.8
070122a	R Gem	2	4	7.1
072708	S CMi	6	10	7.5
0728*20*b	Z Pup	6	6	7.9
081112	R Cnc	5	13	6.8
081617	V Cnc	9	10	7.9
0824*05*	RT Hya	3	26	7.5
		12	7	
084803	S Hya	8	9	7.9
085008	T Hya	7	15	7.7
0929*62*	R Car	6	2	4.5
093934	R LMi	8	17	7.2
094211	R Leo	3	3	5.9
10066*1*	S Car	1	16	5.7
		6	14	
		11	10	
103769	R UMa	3	5	7.6
		12	31	
1144*41*	X Cen	8	19	7.8
1214*18*	R Crv	1	11	7.6
		11	24	
122001	SS Vir	4	6	6.9
123160	T UMa	2	10	7.9
		10	25	
123307	R Vir	2	25	7.1
		7	20	
		12	12	
123961	S UMa	5	23	7.9
1324*22*	R Hya	2	19	4.5
1327*06*	S Vir	1	26	7.1
1331*55*	RV Cen	1	22	7.6
1336*33*	T Cen	2	16	6.1
		5	18	
		8	17	
		11	16	
134440a	R CVn	1	26	7.7
		12	18	
1409*59*	R Cen	2	26	6.0
142539a	V Boo	6	22	7.9
143227	R Boo	6	16	7.3
151731	S CrB	9	2	7.5
1518*22*	RS Lib	3	25	7.7
1528*49*	R Nor	5	16	7.2
1536*54*	T Nor	2	24	7.4
154615	R Ser	9	4	6.8
154639	V CrB	6	26	7.4
1621*12*	V Oph	3	18	7.5
162119	U Her	1	25	7.6
163266	R Dra	2	9	7.6
		10	12	
164715	S Her	6	10	7.6
164844	RS Sco	8	3	6.8
1650*30*a	RR Sco	6	17	6.0
1702*15*	R Oph	8	29	7.6
183308	X Oph	3	17	6.8
190108	R Aql	5	11	6.2
1910*19*	R Sgr	1	9	7.2
		10	5	
193449	R Cyg	6	14	7.3
194048	RT Cyg	6	20	7.4
		12	27	
1946*59*	S Pav	4	18	7.3
1949*29*	RR Sgr	11	20	6.6
1951*42*	RU Sgr	4	25	7.2
		12	22	
200938	RS Cyg	10	18	7.4
201647	U Cyg	10	17	7.0
2044*05*	T Aqr	4	21	7.6
		11	9	
210868	T Cep	12	14	6.1
213753	RU Cyg	6	28	7.5
2219*48*	S Gru	8	29	7.6
230110	R Peg	12	31	7.9
230759	V Cas	2	26	7.8
		10	13	
2338*15*	R Aqr	3	20	6.4
2351*50*	R Phe	6	9	7.5
2357*15*	W Cet	4	15	7.4

Dates of Maximum of Bright Long-Period Variables, 1943: Some of the long-period variables attain naked-eye visibility at their maximum light, while still more reach a maximum brightness above the eighth magnitude. In order

that readers may have some idea as to when to observe some of the more interesting, bright stars when at maximum light, the preceding list of predicted dates of maximum is given. The probable magnitude at maximum phase for each star is also indicated, but it must be remembered that these magnitudes are mean values only, and that individual stars at different maxima may depart materially from the values mentioned. For stars in the first twenty hours of right ascension these mean maximum magnitudes have been newly derived from observational data covering the past twenty years. The dates listed are intended to indicate the time of maximum light, but usually the variables hover near the maximum for some days preceding and following these dates.

Observations received during December, 1942:

Name	Var.	Obs.	Name	Var.	Obs.
Blunck	15	16	Maupomé, A. S.	119	124
Boone	8	8	Maupomé, Enrique	16	16
Bouton	46	65	Mayall, Mrs.	1	12
Cousins	35	47	Meek	28	148
Dafter, Mrs.	4	7	Nadeau	40	51
deKock	65	224	Paraskevopoulos	1	5
Duncan	1	2	Parker, E.	5	6
Duffie	16	17	Parker, P. O.	22	25
Erdman	12	24	Parks	21	37
Fernald	256	402	Peltier	81	124
Garneau	23	24	Pouliot	7	11
Harris	40	41	Rosebrugh	13	55
Hartmann	155	186	Sanders	18	22
Hiett	14	34	Segers	7	28
Hinshaw, Mrs.	1	7	Sill	46	47
Holt	172	406	Topham	36	36
Houston	11	11	Vohman	26	29
Howarth	12	15	Weber	54	54
Huffer	7	10	White	1	1
Kearons, Mrs.	73	128	—		—
Koons	74	131	40	Totals	2636

January 15, 1943.

Comet Notes

By G. VAN BIESBROECK

Comet 1942 *f* (Whipple). Before the end of 1942 one more new comet was announced. It was found by F. Whipple on sky-patrol plates at the Harvard Observatory. This is the second comet found in 1942 by the same observer. The first information was broadcast on December 12 and gave the following data:

1942 December 8 at $5^h\,38^m$ U.T. $7^h\,50^m.2$ $+15°\,24'$
Magnitude 10. Diffuse
Daily motion $+1^m\,40^s$ and $+0°\,19'$

This was immediately confirmed by several observers. The discoverer traced the object back on earlier Harvard plates so that he was soon able to compute a reliable orbit:

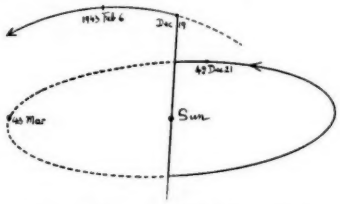
Parabolic Orbit of Comet 1942 *f* (Whipple)

Perihelion time 1943 Feb. 6.659 U.T.		
Node to perihelion	39° 46′	1942.0
Longitude of node	100 3	
Inclination	19 46	
Perihelion distance 1.355 astr. units.		

The corresponding ephemeris is here extended as follows:

1943	α h m	δ ° ′	Distance from Earth	Sun	Mag.
Feb. 9	11 4.8	+52 54	0.453	1.356	5.5
13	20.6	53 59	.466	1.359	5.6
17	35.2	54 42	.480	1.364	5.7
21	48.3	55 4	.496	1.372	5.7
25	11 59.8	55 7	.514	1.382	5.9
Mar. 1	12 9.5	54 53	.533	1.395	6.0
5	17.6	54 26	.553	1.410	6.1
9	24.2	53 46	.575	1.427	6.2
13	12 29.5	+52 54	0.598	1.446	6.4

The position of the path in space is shown by the figure where the earth's yearly orbit around the sun is represented by an eclipse in perspective. The comet



ORBIT OF COMET 1942 *f* (WHIPPLE)

crossed the ecliptic from south to north on December 19 and will stay north for several months in the constellation of Ursa Major.

When seen here first on the night of December 13 the object appeared as a large coma about 7′ in diameter with a well-defined nucleus. A faint tail in position angle 280° could be traced to nearly 45′ from the nucleus. The visual brightness was estimated by extrafocal comparison as 7.6 magnitude. During December the light increased and by January 12 I estimated the magnitude as 5.4 with a binocular; this made the object just visible with the naked eye. The tail extended at that time over more than a degree in length. The maximum brightness is expected toward the end of January but will probably not be greater than magnitude 5. The ephemeris shows that the comet will remain fairly bright for some time to come.

The only other known comet under observation is 1942 *e* (OTERMA) which follows closely the ephemeris given last month. It was independently discovered on December 26 at Abastuman (Caucasus) by Tevzadze. As expected the maximum brightness was reached in December. The distance is increasing now and last night (January 12) I estimated the magnitude as 10. The comet is still located favorably and will be followed for several months in the early part of the night, but the light is falling off as can be seen from the following ephemeris extrapolated from last month's:

1943	α h m	δ ° ′	Mag.
Feb. 1	4 43.2	+36 17	11.1
5	5 51.2	37 9	
9	4 59.9	37 54	
13	5 9.3	+38 32	11.6

PERIODIC COMET WOLF I has again been observed early in December by Dr.

Baade, using the 100-inch reflector at Mount Wilson. It was then an extremely faint little coma.

Also PERIODIC COMET SCHWASSMANN-WACHMANN I was recorded by the writer on January 5 and 6 as a very diffuse coma of about magnitude 16. The comet will soon be lost in the western sky.

The search for the expected PERIODIC COMETS REINMUTH and NEUJMIN (2) for which ephemerides were given last month has not been successful so far.

Williams Bay, Wisconsin, January 12, 1943.

Communications and Comments

Under this heading we shall publish from time to time such material as does not properly fall under any of the established headings of this journal. Here, too, may be found, when occasion arises, articles which the editor may not be willing to give sanction to but which, nevertheless, may be provocative of thought along new lines.

Editor of Popular Astronomy: In the paper which appeared in POPULAR ASTRONOMY **50**, 252, you call for "errors" in the "Errors in 'Marvelous Voyages, II'," so I will try to oblige. These are all rather quibbles, and yet have a certain validity.

Item 15. Seven *is* a legitimate number for colors of the spectrum, and was of course the traditional number in the English-speaking world from Newton to my father's generation, interpolating "indigo" between blue and violet. Of course the number is indeterminate: I think naive persons see three colors in the rainbow (red, green, blue) since the yellow is so narrow and of such low saturation as not to be considered. The Helmholtz theory also adopts the same three colors as primaries, while the Hering theory adds yellow; when in school they taught me six (from the artist's tradition)—three primary, red, yellow, and blue, three secondary, orange, green, violet. The introspective phychologists choose a larger number, counting all that strike one at a glance as different, even if similar, *e.g.*, grass green and poison green. Finally there are about 100 distinguishable hues along the line of the spectrum. So take your choice: 3, 4, 6, 7, 15 ± 5, 100 ± 20.

(By the way, note that in the pure spectrum the last color is indigo, the violet being caused by a faint admixture of white light in all but the most carefully shielded spectrographs. But I suppose few even in ordinary physics laboratories have seen 3800 Å as indigo. Also under physics laboratory conditions with a dim light and a dark surrounding field, yellow is always contaminated in the spectrum with a faint subjective overcast of orange or green, and the pure blue band is much narrower than with higher illumination and a brighter surrounding field, so practically all physicists get in the habit of ignoring these colors, calling the sodium orange, yellow, and the end-spectrum indigo or even violet, blue. Also the Hering primaries are not those of the artists, but a magenta, sodium orange, blue-green and then a normal blue.)

Item 25. As mutation takes place in vegetative as well as germ tissues we could easily think of this type of evolution: assume merely that tissue was haploid (as in many lower plants) so that point-mutations would show immediately; and

then perhaps if you wish things to go faster postulate less effectively protected meristem tissues or a lot of ultraviolet.

Item 26. Of course evolution would go on without selection, the real catch is that over 90% of mutations are regressive, so without selection it would on the whole go backward; just as it always does with civilized man between periods of barbarism.

Wm. T. M. Forbes.

Department of Entomology, Cornell University Agricultural Station, Ithaca, New York.

Reply by Dr. Laurence Lafleur

Item 15. I acknowledge myself answered. My inquiry was as to the source of the number seven, which figure I had met before in dealing with colors. The seventh name, "indigo," has of course fallen into disuse generally.

I might, however, clarify my selection of the number four in this connection. Physical distinction is evidently not in question, since this number would be, as far as we know at present infinite. Nor is it a matter of distinguishable hues, as that gives much too large a number. Four did not refer to the minimum number of pigments needed to prepare colors, nor to the number of physiological poles or pairs involved in color vision, but to the number of colors which are introspectively distinct in the sense of not appearing similar to or a mixture of other colors. To put it more clearly, orange appears to be a mixture of or similar to red and yellow, but yellow, red, green, and blue do not thus appear to be mixtures.

Item 25 and item 26. Professor Forbes is quite correct in stating that change would take place. I was using evolution to mean something more than mere change: the development of major organically related wholes. The chance of such a development in a single organism, or in a series of organisms not subject to selection, is the product of the separate probabilities of the separate mutations, also multiplied by the probability of the non-occurrence of interfering changes. In other words the probability is so remote as to become an impossibility.

In an article in your December issue Mr. J. B. Penniston gives description of the Zodiacal Light, also his opinion as to the cause of this phenomenon. His preference as to a theory of the cause is expressed in these words, "The theories of it as a ring around the Sun or a disc-like envelope of that body strike me as much more reasonable."

It seems to me that one observation cited by him is enough to bar the theory that it is anything outside of the Earth's atmosphere. This is the fact that it wavers or flickers. Mr. Penniston speaks of "very rapid pulsations."

Nothing at a distance as great as the Sun or anything approaching that distance could possibly appear to pulsate rapidly. To move across the line of sight at a distance of 93,000,000 miles away, even as rapidly as once in a second across the apparent diameter of the Sun, would mean nearly a million miles a second. This is more than five times the velocity of light, and once across the distance of the Sun's apparent diameter in a second would be a very slow "flicker."

The Sun's corona, and the other visible spouts of matter from its surface, though they manifestly move with great velocity, appear to be stationary under observation; any change is gradual. There are no flickers in anything at astronomical distances from the Earth.

Mr. Penniston says, "I have been impelled to write this description of the Zodiacal Light by recent theories advanced, urging the Light either as Earth-ring or as an atmospheric phenomenon." The theory that it is an atmospheric phenomenon has been publicly advanced by me a number of times; furthermore I have given what I believe to be the exact cause of the light. No one has attempted to controvert my theory.

In a contribution in POPULAR ASTRONOMY, for October, 1939, I pointed out that the upper layers of the Earth's atmosphere in the tropics are moving at great velocity, always in an eastern direction and that these layers moving on one another generate static electricity. It is this electric manifestation, *in the Earth's atmosphere,* that gives us the Zodiacal Light.

In my book of Structural Tables, in a compiled list of eleven pages of my published contributions, among the things I am endeavoring to convince men to be true, I have stated, "Aurora Borealis and Zodiacal Light are of one nature; they are due to static electricity generated between moving layers of the Earth's upper atmosphere."

The reason that more light is seen near the horizon is because the horizontal line of sight of an observer, say through an atmosphere 500 miles deep, is four times as long as a line of sight directly vertical. There are, therefore, more electrically illuminated layers to penetrate near the horizon.

In "Enclyclopedia Britannica," under Zodiacal Light, we read that F. J. Bayldon found a lunar cycle in the brilliancy of the Zodiacal Light. He found that the Moon adds to that light during her first and last quarters. He could see the Zodiacal bands *across the entire sky* during every clear, moonless night in the tropical regions. These facts certainly connect the Moon with the source of this light, as my theory dictates, and completely eliminate the commonly held solar atmosphere theory. This atmosphere could not reach beyond the earth.

As I have pointed out in various contributions, it is satellites that force the primary to rotate and force any fluids on the surface to move, angularly, ahead of the rotation of the primary, hence the eastern motion of the Earth's upper atmosphere in the tropics.

EDWARD GODFREY.

Pittsburgh, Pennsylvania, December 14, 1942.

Cosmos

"Let there be light," rang the Creator's fiat. There was light and the morning stars sang together. To light and its speed seem wedded the ultimate problems of physics and the universe.

About the speed of light, we may remark a curious effect. Could we exist and move at twice this speed, overtaking its rays at their own rate, and looking ahead with vision cleansed, we would see events retraced backward; then, standing still, we could read them over again! This apparent reversal of the time machine suggests one way of keeping the eternal records.

A ray of light twinkles through 186,000 miles—just 7½ times round the world— in a second. To attain such a speed, a stone would have to fall (free of any air-resistance) for within ten days of a whole year under the acceleration of gravity. At this speed, the ray of light covers 5,880,000,000,000—nearly six billion—miles, in one year. This unit is known as a "light-year" and, though quite unimaginable, can be compared by marking the Sun down as the tiniest dot, round

which the Earth's orbit would be a circle the size of a serviette-ring (two inches across) and the Solar System (Pluto included) cover a round table about 6½ feet across; on this model, the light-year becomes just one mile! Where our imagination fails, of course, is in the packing into one inch our 93 million miles from the Sun. Still, the comparison provides a convenient unit for expressing stellar distances. Our nearest known star is just over 4¼ light-years (miles on the model) away, while the stars around the Sun average 8½ light-years apart. Which shows how lonely are the stellar families in space! Some of the faint stars (Suns) are relatively near, while bright ones are often a great deal farther off; many that we see stand round the five centuries mark, including three of our first-magnitude stars: Arided (at the Swan's tail), Rigel (Orion's foot), and Canopus (the Ship's Rudder), this last the next to the brightest star in our sky; whence the first two must outshine our Sun more than ten thousand fold and the last around fifty thousand fold—supergiants in our universe.

Until recently, the term "Universe" included all that we can see with the naked-eye or through a telescope—Sun, Moon, planets, stars, star-clusters, and nebulae—making up the disc-like structure seen as the Milky Way or Galaxy, with a diameter estimated at 6000 light-years. Now, we have to define the term in limiting it to what actually belongs to the Galaxy, differentiating this from the far vaster "Cosmos" including myriads of such "universes."

Within the last quarter-century, the 6000 light-years assigned to our universe is found to represent but its nucleus at our end, and known as the "local cluster," the universe being extended to 100,000 light-years across, with our Sun and his neighbors of the local cluster forming a knot, two-thirds way from the centre, (which lies toward Sagittarius, the Archer) fully 30,000 light years distant. Round this dynamic centre our cluster travels (toward Cygnus, the Swan) at some 170 miles a second. This is known as the "galactic rotation."

Sir William Herschel, a century and a half ago, the propounder of the discoid universe (though in different form), had the insight, even then, to speak of "Milky Ways" in the plural, though naturally unaware of their gigantic scale. He was about the first observer of those faint, hazy patches, known as star-clusters and nebulae and catalogued together on the assumption that, given the telescopic power, all would resolve themselves into minute stars. Many of these, however, are found to persist as gaseous patches—real nebulae.

These true nebulae, of which a mere handful can be seen with the naked-eye, fall into two distinct groups—the "galactic" and "extra-galactic"—according to their distribution within or beyond the Galaxy. The galactic nebulae, known as "green" (from this their colour when shining at all) show the characteristic spectrum of rarefied gas; whence their alternative name "gaseous" nebulae, and the alliterative association "green, gaseous, galactic." They are really dark, shining only by light reflected from an adjacent star, or translucent with the light of one within or behind. Notable examples are the Orion and the Great Nebula in Argo (the latter rather submerged in the Milky Way). Many are unlighted and show as dark patches or apparent rifts in the Milky Way—as that from Aquila in Argo (the latter rather submerged in the Milky Way—as that from Aquila to Cygnus, also the noted oval "Coal Sack" in the Southern Cross. So our Galaxy is like a vast night landscape, whereof only its lights (stars) trace habitations (planets) couched around with reflections, ever too feeble for our seeing; here and there misty mountains (galactic nebulae) betray themselves amid their background of light, obscured, reflected, or transfused.

The extra-galactic nebulae, on the other hand, shine by their own light—

hence called the "white" nebulae—and, standing right away from our stellar system, are as distinct from the green nebulae as the stars are from the planets of our Solar System. Belonging thus to a higher order in the celestial scale, the white nebulae rank as "universes" and, photographed in large telescopes, resolve into stars, clusters, and nebulous clouds, like those within our own universe. Their number seems limited only by the power of our telescopes to photograph them, and are more or less evenly distributed through outer space at about a million light-years apart. Some of them are comparable with our own universe in size (though not in mass, it seems), the majority being a deal smaller—whence aptly christened "island universes" with a few (say) "continental" ones like our own, all comprehended within the great Cosmos. The largest of them—and the only one visible (as a hazy fourth-magnitude star) to the naked-eye—is the Great Andromeda Nebula, about as big as our Galaxy and about the nearest, being some 850,000 light-years away—which marks the answer to the old question "How far can you see?", namely five trillion (million times a million times a million) miles!

Now these island universes all seem to be running away from us, at speeds proportional to their distances—at 100 miles a second for every million light-years away; any nebula thus doubling its distance in 1400 million years. Hence arises the talk of an "expanding universe" or, more correctly, expanding Cosmos. This means that the universes 3000 million light-years out must be moving away at the speed of light. Again, according to the Theory of Relativity (with the "Fitzgerald-Lorenzian Contraction"), a moving body shrinks to the proportion, $\sqrt{(\text{vel. of light})^2 - (\text{vel. of body})^2}$ along its line of motion. This (right-angle-triangle) relation is best exemplified in the case of a ball moving at 3/5 the speed of light and so flattening to 4/5 of the axis along its path. Whence, a body moving as fast as light flattens itself to nothingness in one plane—otherwise extinction. Applying this to the Cosmos, none of its radiating universes can exist beyond where they reach the speed of light, namely 2000 million light-years out; this is its consequent boundary, and where, incidentally none of the universe could ever be visible, since, apart from their vanishing into nothingness, they run their light-rays to a standstill for us. All of which means that Cosmos must either infold somehow to "beyond the back of nowhere" or eventually empty itself as its universes radiate to extinction, itself annihilating with the last ones.

Here we note a snag. For us at the centre (so it seems), objects cease to exist at the cosmic boundary, yet, for their inner neighbours, moving nearly as fast, they do exist, though somewhat flattened. Which *reductio-ad-absurdum* makes one feel like a blind man in a dark room, trying to stroke a black cat which isn't there! So evidently there can be another explanation of things. For instance, loss of energy in the photon (corpuscle of light) in its journey through space would show the equivalent of recession and, as proportionate to distance, would be a far more natural explanation than the artificial increase of actual recession with distance and that referred to our universe in particular! So, arguing a finite Cosmos, we thus choose between one expanding to extinction, and one "static," *i.e.*, non-expanding and "everlasting."

Archimedes, the (3rd century B.C.) founder of the train of mathematical ideas down through Galileo and Newton to Einstein, argued against infinity in his tract "On the Grains of Sand" to King Gelon of Syracuse, as follows: "There are those who think, King Gelon, that the number of grains of sand is infinite;

that is, the grains of sand, not only in the environs of Syracuse and the rest of Sicily, but also in all parts of the world, whether inhabited or uninhabited. Others think that it is not infinite, but that no number can be named so large that it would exceed the said number of the grains of sand. It appears that those who think so would still less be able to imagine a number exceeding that of the grains of sand which would compose a globe of the same size as the Earth, filling up all the seas and cavities to the level of the highest mountains. I shall, however, try to prove to you by mathematical reasonings, which you will be able to follow, that some of the numbers, which I have named and explained in the book that I sent to Zeuxippus, do not only exceed the number of grains of sand in a globe equal to the Earth, thus filled up, but also that of those in a globe equal to the whole universe." So the preamble of Archimedes, whose point is that, however many the grains of sand counted, one must be the last. The universes within the Cosmos at its stated limit should be around 5000 million, while, at their estimated density, the number of protons (positive electrons) would reach 7×10^{78} (7 followed by 78 ciphers!). This is the answer to Archimedes' problem, as a number definitely finite, though transcendentally incomprehensible.

Recently, however, Shah Sulaiman (an Indian mathematician) has propounded an explanation of observed facts, without the Theory of Relativity, and restoring our Euclidean three-dimensional space to its vacated throne, together with unending time and limitless space.

So we come to our last main point, Infinity, which must be distinguished from boundlessness. To illustrate: imagine a two-dimension being, unable to conceive depth, to travel in a straight line round a sphere (of radius R) and duly arrive (after a journey of $2\pi R$) at his starting point, and that from the opposite direction to that of his going. Unable to conceive depth, he could never understand our explanation of his path (straight to him) curving downward in a circle and so bringing him back to his starting point after a journey of a length which he could calculate as the product of his speed and the time taken; nor could he understand why he seemed to arrive from the opposite direction. In this connection, by the way, we have our mathematical analogy in the equality between plus and minus infinity for the tangent of 90°—according to whether we approach it from the first or from the second quadrant. Our two-dimension friend's journey, though definitely finite, is nevertheless unending, or boundless. So, again, he could go right and left, exploring the surface of his sphere and find it of a finite area ($4\pi R^2$) and yet without any boundaries. Rising one dimension higher what is to us endless or boundless space might well be a definitely finite number of cubic miles, etc., "curving" in to repeat itself thereafter as conceivable only to some four-dimension being, who could also express the four-dimensional "solidity" in units incomprehensible to us—just as we might vainly try and explain to Mr. Two-dimension the cubic contents of the sphere ($4/3\pi R^3$) in the solid three-dimension units which he could not conceive.

For us to conceive a four-dimension solid, we must invent some way of twirling a sphere about its *surface* as axis—the rule being that, in order to generate a dimension higher, $(D+1)$, we must swing the present dimension (D) about the next dimension $(D-1)$ lower. All we can do is to rotate our sphere (3.D) round an *axis* (1.D), which, being two dimensions down, will not do—any more than our two-dimension friend could expect to get anything more than a circle (2.D) by twisting it round its centre (a point of 0.D) two dimensions down.

As he would not understand depth so as to lift his circle round a diameter to develop a sphere, so cannot we realize the fourth dimension into which we must turn our sphere about its surface for the next "solid" higher. Throwing the ball about is merely equivalent to rotation about an ever-changing instantaneous centre (point or line, as the case may be) outside of itself. Though visually inconceivable, to us, a mathematical analogy from the square suggests certain properties of the four-dimension "cube," say "quadrube": as the diagonal, numbers of faces, and corners in the square are $\sqrt{2}$, 4, and 4, while those respectively in the cube are $\sqrt{3}$, 6, and 8; whence our "quadrube" should have a diagonal twice ($\sqrt{4}$) as long as its side, 8 "faces" and 16 "corners."

Carrying the analogy further, all that our two-dimension friend sees of his conceivable area-world is its edge as a (one-dimension) line—just as we see a continent as a shore line, instead of as a land surface, this because we do not actually (though we can mentally) rise high to see it thus. So, all we really see of our three-dimension world is the two-dimension surface of its volume, which latter we don't "see"; you may ask, "What about looking through a block of glass?"; well, looking through it is simply on to some opaque surface beyond it, merely side-tracking, as it were, the intervening solidity of the glass.

Taking leave, we may remark Time as meeting some aspects of a fourth dimension. For anything to exist at all, it must have a time dimension, that is, have a period of existence—some age. Hence the metaphysical bulk of anything is the product of its four factors: length, breadth, height, and age—any one of which being zero, reduces it to extinction. Spatially, our trouble here is the correlation between time and space—suggestive of motion, which in turn has (as we have seen) a vanishing point in the speed of light—perhaps!! One thing we can see, anyway, about the time dimension, is that for any two bodies to meet, they must be at the same point in space—satisfying its three coordinates, *and* this at the same moment in time. Motor cars can safely pass at crossroads, so long as one crosses before the other, so as to miss along the time dimension; if not missing here, then it must be a miss in one of the space dimensions, say by an overhead bridge.

O. R. WALKEY.

Notes from Amateurs

A Tiny Telescope

Since he began observing variable stars in 1932 the writer has been troubled by trees which obstruct the sky, hence he has had to place his principal reliance on portable refractors of from 2.75 to 4 inches aperture, mounted on tripods, which can be carried from place to place to dodge the foliage.

To try out the relative merits of reflectors the writer has assembled a small reflector on a portable tripod mounting and on October 10, 1942, he demonstrated this instrument under the title "A Tiny Telescope" at the A.A.V.S.O. meeting at Harvard.

The telescope is a Richest Field Telescope (RFT) with a pyrex mirror 4½ inches in diameter of 15-inch focal length made by Mr. Roy A. Seely, First vice-president of the A.A.V.S.O. The tube is 5 inches in diameter and 20 inches long. A 1½-inch octagonal flat is used as a diagonal. Focussing is of the micrometer

type. Positive eyepieces of 1-inch and 0.4-inch focus are used giving powers of 15X and 37X.

After experimentation it was found that a finder was required. This has a 1-3/16-inch objective of 6½ inches focal length and a power of about 6, with which stars of the 8th magnitude can be seen. Its field of view completely embraces the circle of stars in Corona Borealis.

The RFT is mounted on a knock-down pipe tripod with an alt-azimuth head, which was made by one of the well-known amateur supply dealers. The bearings of the mount are fine threads cut in 1-inch solid brass rods, one of which forms the vertical azimuth axis and the other the horizontal altitude axis. This mounting was intended for a 6-inch reflector with a 7-inch tube so that some felt padding was required on the cast iron saddle to adjust it to the 5-inch tube of the RFT, but the extra strength of the mounting makes it very solid and smooth in its action.

It was found desirable to mount the RFT in such a position that when the telescope is pointed to the left, at the horizon, the eyepiece and finder are on its upper side, and on the left end. The eyepiece lies nearer the observer and the finder is beyond it, nearer to the tripod. This position of the eyepiece and finder gives maximum convenience for an observer who uses his right eye at the telescope eyepiece.

Approximately 200 observations of variable stars have now been made with this "tiny telescope." In practice the instrument is used as follows: The finder is used to locate some asterism such as Corona Borealis, which is near the variable star, in this case R Coronae Borealis. The finder which has not cross-hairs is then centered on the location in the sky at which the variable star is known to lie. The RFT with the 15X eyepiece, which shows stars down to the 10th magnitude is then used to search for the variable star. Since the RFT is on an alt-azimuth mounting the variable star field, as seen in the eyepiece may lie at almost any position angle, but as pointing the finder has already made it certain that the variable must lie in the field of view of the RFT no difficulties have been experienced in locating any variable star, though a beginner at variable star observing might have a little trouble. In the recent descent of R Coronae Borealis the 15X eyepiece sufficed to follow the star down to about the 9.5 magnitude. Below this point it was necessary to use the 37X eyepiece, with which R CrB was followed as low as the 11.5 magnitude.

DQ (Nova) Herculis 1934 at 11.8 magnitude has been repeatedly seen and also SS Cygni at minimum, with the 37X eyepiece, despite the fact that the aluminizing on both mirror and diagonal is five years old. The instrument seems to be of little value on the planets, though it is excellent for looking at the star cluster in Hercules, the nebula in Andromeda, the double cluster in Perseus and the Milky Way.

It is probable that the 4-inch portable refractor of short focal length, which the writer has, is somewhat superior to this tiny RFT, for variable star work, but the RFT has the following comparative merits: The eyepiece position is more convenient. It is somewhat easier to shield ones eyes from nearby street lights when looking down into the RFT eyepiece than it is when looking upwards through the refractor eyepiece. The RFT shows nearly as faint stars, 11.8 *cf.* 12.2, as the refractor. The RFT has an extraordinarily wide field of about 3½ degrees at 15X. The *tout ensemble* weighs only 25 pounds as compared to about

100 pounds for the 4-inch refractor, hence it is easily portable. The RFT with 2 eyepieces, finder and mount cost only $33, as compared to approximately $200 for the refractor, which was constructed from used war material from World War I.

The low price of the reflector was only possible because almost all the component parts were bought at low prices from second hand shops in New York City.

D. W. Rosebrugh, *Secretary*, A.A.V.S.O.
87 Fern Circle, Waterbury, Connecticut.

General Notes

The Rittenhouse Astronomical Society, of Philadelphia, held its monthly meeting on Friday, January 8, 1943, in the Lecture Hall of The Franklin Institute. The new president, Armand N. Spitz, was installed. An address was given by the retiring president, Dr. Charles P. Olivier, Director of Flower and Cook Observatories of the University of Pennsylvania, his subject being "Observational Practice for Variable Stars."

Summary of Sun-Spot Observations at Mount Holyoke College, 1942

Month	No. of Obs.	North of Equator No. of Groups	North of Equator Av. Lat.	South of Equator No. of Groups	South of Equator Av. Lat.	Av. No. Groups at one Obs.	New Groups
January	22	4	+11°0	8	—10°0	2.3	12
February	18	9	9.3	7	9.0	3.5	15
March	14	9	9.1	4	8.2	2.4	9
April	21	12	9.1	8	7.3	3.8	17
May	19	5	11.9	2	6.2	1.9	5
June	11	1	5.7	1	9.0	0.9	2
July	16	0	....	6	5.5	1.1	6
August	18	6	7.3	2	4.5	1.8	7
September	13	2	10.5	2	11.5	1.4	4
October	24	5	7.7	8	9.8	1.5	12
November	20	2	5.5	11	8.0	1.8	11
December	13	5	13.6	3	9.3	2.2	4
	209	60		62			104

Average number of groups at one observation	2.11
Average latitude of spots north of equator	+ 9°5
Average latitude of spots south of equator	— 8°3
Number of days without spots	24

February and April were months of activity considerably above the current average. It is to be noted that during the last week in February the group (latitude +10°, longitude 200°) recorded as having the most powerful magnetic field ever measured at Mount Wilson crossed the Sun. The March return of this group fell largely in spring vacation.

Our figures show activity much more nearly uniform (both in number of groups and average latitude) in the two hemispheres than for several years. The combined average latitude north and south has diminished only 0°4 since the previous year.

The 24 spotless days comprise 11 per cent of the total number of days on

which observations were made, as compared with 3 per cent in 1941.

Observations have been made largely by Miss Jocelyn Gill (January to May), Miss Patty Thompson (June to August), and Miss Helen Pillans (September to December). The total number is larger than usual because Miss Thompson took the responsibility for maintaining the record while attending Mount Holyoke Summer School.

ALICE H. FARNSWORTH

John Payson Williston Observatory, South Hadley, Massachusetts.
January, 1943.

Northfield Observatory

It is quite appropriate that the following description of the Northfield Observatory, mentioned on page 1 of the preceding issue, should appear in this journal, which has been sheltered by its successor, the Goodsell Observatory, for fifty years. It is taken from *Science Observer,* a journal for scientists, Boston Amateur Scientific Society, issue of July, 1877, Pg. 3, and was sent to us recently by Ben Hur Wilson, Joliet, Illinois.—ED.

Carleton College, Northfield, Minnesota, has just completed an observatory, which will in future, no doubt, be of great value, and which in its construction and appointments does great credit to the institution supporting it. The observatory building consists of a main part, twenty feet square, surmounted by the dome, and two wings, one of which is designed for the transit room, the other for the library. The transit instrument was made for the college by Messrs. Fauth & Company, of Washington, costing $900, is well supplied with the necessary appliances, with varying powers to eighty, and illumination on the new plan through the axis, with side reflector.

The observatory is to have two clocks, one of which, the sidereal, is already in position. It is from the manufacturers, E. Howard & Company, Boston, and is of the same style and quality as that recently completed for Princeton College. A 4-inch equatorial will for the present be used, pending the construction of an 8½-inch instrument, with focal length of 12 feet, which will be mounted in the most approved style, driving clock and circles complete.

The Steamship George E. Hale

The following was sent to this office as "advance data on launching of the *S.S. George E. Hale,* Calship No. 125." By the time this item reaches the readers it will be history. Nevertheless, it will be of great interest to all who are in any way interested in astronomy, because of the impetus and support given to this science by the person for whom this ship is named.

Tuesday, January 19, 1943, 10:00 P.M.

Sponsor: Mrs. George E. Hale,[1] widow of George E. Hale.
Matron of Honor: Mrs. Paul A. Scherer,[2] sponsor's daughter.
Master of Ceremonies: John D. Burton, Employee Relations Manager, California Shipbuilding Corporation.

GEORGE ELLERY HALE, (1868-1938), American astronomer

George Ellery Hale was born in Chicago, Illinois, on June 29, 1868. He graduated at the Massachusetts Institute of Technology in 1890 and carried on

[1] Resides at the Huntington Hotel, Pasadena.
[2] Of 211 Marguerita Avenue, Santa Monica.

research work at the Harvard College Observatory (1889-90) and the University of Berlin (1893-94).

In 1888 he organized the Kenwood Observatory in Chicago, where he invented and developed the spectroheliograph, an instrument for photographing the sun in monochromatic light. Later professor in the University of Chicago, he began the organization of the Yerkes Observatory, of which he was director until 1904. In 1895 he established the *Astrophysical Journal,* an international review of spectroscopy and astronomical physics.

In 1904 Hale organized the Mount Wilson Observatory of the Carnegie Institution of Washington, and was its director until 1923, when be became honorary director.

His researches in solar physics and stellar evolution have been recognized by the award of many medals and prizes and honorary degrees, and by his election as a foreign member of the Institute of France, the Royal Society of London, and most of the leading European academies of science. He assisted in the organization of the California Institute of Technology and the Huntington Library and Art Gallery, of which he was a trustee.

He died on February 22, 1938.

Data regarding *S.S. George E. Hale.* Keel laid: December 23, 1942. Launched: January 19, 1943. Days on ways: 27. Ships launched to date: 125. Ships delivered to date: 117.

Book Reviews

The Origin of the Carolina Bays, by Douglas Johnson. Columbia Geomorphic Studies, No. 4. Pages: xiii +341. (Columbia University Press, Morningside Heights, New York. $4.50.)

The Atlantic coastal plain in North and South Carolina is literally peppered with curious craters. The discovery was first made at the end of the nineteenth century, and various hypotheses have been offered as to the cause of them. Within the last ten years, however, interest in these new land forms has increased tremendously, due chiefly to the fact that the aerial photograph has revealed hundreds of these craters where topographic maps have shown but one or two. It is believed that there are literally hundreds of thousands of these craters in this particular area.

The most spectacular, or at least the most highly publicized, theory of their origin has to do with meteorites, and this despite the fact that the area of most abundant meteorites is considerably west of the coastal plain. These craters are, in the main, elliptical or ovoid. Their axial relationships are uniform enough to be significant. All in all, the theory has been accepted popularly that these were caused by a hail storm of meteorites that struck the earth at an angle.

The author of this book, however, offers a new hypothesis, and one that must be considered in its entirety before it can be dismissed or before any other hypothesis can be accepted.

CONTENTS

1. Introduction. 2. Nature of the Bays. 3. Scientific Studies of the Bay. 4. Hypotheses Based on Supposed Terrestrial Origin of the Bays. 5. Hypothesis of Ancient Meteorite Scars. 6. Hypothesis of Recent Meteorite Scars. 7. Further

Tests of Meteoritic Hypothesis. 8. Magnetic Tests of the Meteoritic Hypothesis. 9. The Hypothesis of Complex Origin. 10. Competence of the Hypothesis of Complex Origin. 11. The Artesian Phases of the Hypothesis. 12. The Solution Phase of the Hypothesis. 13. The Lacustrine Phase of the Hypothesis. 14. The Aeolian Phase of the Hypothesis. 15. Possible Weaknesses of the Hypothesis. Index.

The Revolving Heavens—Astronomy for Observers with the Naked Eye, by Reginald L. Waterfield. 206 pp. (Duckworth, London, 8/6 net.)

This is a compact pocket handbook for the naked-eye astronomer. Its main value is in giving a perspective or bird's eye-view of the universe in a nutshell. It is a useful piece of portable equipment far more easily handled than larger books requiring indoor concentration. Its emphasis is on the explanation of celestial naked-eye phenomena such as the harvest moon, star movements from different latitudes, lunar phases, etc., rather than on constellation study. In fact it is more of an informational handbook than a guide to observation.

This book will be very interesting to the night workers and other curious minds who newly discover the ocean of worlds above them, but to the amateur who is acquainted with the elementary aspects of astronomy it will only be another repetition of classical astronomy on a very small scale. It contains thirty ink drawings of a diagrammatic nature with no half-tone illustrations. First a general view of the universe is given, then the fixed stars, with their positions, and time are discussed, after this the Sun, Moon, and planets are treated, and finally the book gives a view into the universe beyond the solar system, and touches on comets near the end. It is by the author of the well-known book, "A Hundred Years of Astronomy."

LESTER SUSSMAN.

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Publications Received.—The publishers of POPULAR ASTRONOMY hereby acknowledge receipt of the following named publications and express their great appreciation of the courtesy shown on the part of those who have sent them.

Publications of the David Dunlap Observatory:
"The Radial Velocities of 374 Stars," by R. K. Young.

Publications of the Astronomical Observatory, University of Minnesota:
"On Kopal's Work on the Central Density of the Stars" by Willem J. Luyten.
"New Stars with Proper Motions Exceeding 0".5 Annually," by Willem J. Luyten.

Contributions from the McDonald Observatory:
No. 40. "The Spectra of Wolf-Rayet Stars and Related Objects," by P. Swings.
No. 41. "Extended Stellar Atmospheres: A Review of the Problems of Gaseous Shells," by Otto Struve.
No. 42. "Spectrographic Observations of Peculiar Stars." III, by P. Swings & Otto Struve.
No. 43. "The Spectrum of α Carinae," by Jesse L. Greenstein.
No. 44. "The Nearest Stars," by Gerard P. Kuiper.
No. 45. "The Spectra of α Cygni and α Lyrae in the Region $\lambda\lambda$ 3000-3300, by J. H. Rush.
No. 46. "Remarks on the Spectra of Comets 1941 *c* (Paraskevopoulos-De Kock) and 1941 *d* (Van Gent), by C. T. Elvey, P. Swings, and H. W. Babcock.

No. 47. "Radial Velocities of Proper-Motion Stars," by Daniel M. Popper.
No. 48. "Luminosities of the M-Type Variables of Small Range," by Philip C. Keenan.
No. 49. "Term Analysis of the Third Spectrum of Iron (*Fe* III)," by B. Edlén & P. Swings.
No. 50. "Continuous Emission in the Spectra of Planetary Nebulae," by Thornton Page.
No. 51. "The Spectra of *CH* Stars," by Philip C. Keenan.
No. 52. "The Spectrum of Comet 1942*a* (Whipple), by D. M. Popper and P. Swings.
No. 53. "*Ca* II Emission in 56 Pegasi," by P. C. Keenan and J. L. Greenstein.
No. 54. "Continuous Emission in the Spectra of Gaseous Nebulae," by P. Swings and O. Struve.
No. 55. "Development of the Coronaviser," by H. W. Babcock.
No. 56. "Spectrographic Observations of Peculiar Stars," IV, by P. Swings and O. Struve.
No. 57. "Investigations of Typical Stellar Spectra with High Dispersion" II. "The Spectrum of μ Cygni," by F. E. Roach.
No. 58. "Notes on Proper-Motion Stars." IV, by G. P. Kuiper.

Contributions from the Mount Wilson Observatory:

No. 663. "Spectral Structure and Ionization Potential of Gadolinium I," by Henry Norris Russell.
No. 664. "Discovery and Observations of Stars of Class Be," by Paul W. Merrill, Cora G. Burwell, and William C. Miller.
No. 665. "The Crab Nebula," by W. Baade.
No. 666. "The Crab Nebula," by R. Minkowski.
No. 667. "The Spectroscopic Binaries Σ 1669A and Σ 1669B," by Roscoe F. Sanford and Earl Karr.

Harvard College Observatory Reprints:

No. 238. "Galactic and Extragalactic Studies, XIII. Note on the Comparative Diameters of Spheroidal and Spiral Galaxies," by Harlow Shapley.
No. 239. "The Calculation of Rotation Factors for Eclipsing Binary Systems," by Zdenek Kopal.
No. 240. "Galactic and Extragalactic Studies, XIV. On the Magnitude Dispersion in the Period-Luminosity Relation," by Harlow Shapley, Virginia McKibben, and Richard A. Craig.
No. 241. "Galactic and Extragalactic Studies, XV. On the Distribution of Periods for 343 Cepheids in the Small Magellanic Cloud," by Harlow Shapley and Virginia McKibben.
No. 242. "Theoretical Light-Curves of Close Eclipsing Systems, II," by Zdenek Kopal.
No. 243. "Curves of Growth for the A Dwarfs μ Geminorum and Sirius," by Lawrence H. Aller.
No. 244. "A Study of the Algol System," by Zdenek Kopal.
No. 245. "The Wave-Lengths of New Coronal Lines," by William Petrie and Donald H. Menzel.